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THE WILEY AGRICULTURAL SERIES

EDITED BY

J. G. LIPMAN, B.Sc., A.M., Ph.D., D.Sc.

DEAN OF AGRICULTURE, RUTGERS COLLEGE AND THE STATE UNIVERSITY
OF NEW JERSEY

THE PRODUCTION OF COTTON

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J. G. LIPMAN

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2.

THE PRODUCTION OF COTTON

BY
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"Cotton, what a royal plant it is! The world waits in attendance on its growth, the shower that falls whispering on its leaves is heard around the earth; the sun that shines on it is tempered by the prayers of all the people; the frost that chills it and the dew that descends upon its green leaf is more to England than the advance of the Russian army on her Asian outposts. It is gold from the instant it puts forth its tiny shoot. Its fiber is current in every bank and when, loosing its fleece to the sun, it floats a sunny banner that glorifies the fields of the humble farmer, that man is marshalled under a flag that will compel the allegiance of the world and wring a subsidy from every nation on earth." — HENRY W. GRADY.

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BY

GILBEART H. COLLINGS

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TO MY MOTHER,
HELEN LUKE COLLINGS,
AND
TO MY WIFE,
HAZEL COVER COLLINGS,
THIS BOOK IS AFFECTIONATELY DEDICATED

PREFACE

For many years agronomy teachers in the southern agricultural colleges have felt the need of a college textbook on cotton. This book is the author's attempt to satisfy that need. It is the outgrowth of a series of lecture notes which has been used by him in cotton courses at the Clemson Agricultural College during the last eight years. It has been the author's aim to bring together from his experience and from the great amount of published material the practices of our best farmers, as well as the scattered results of American and foreign research, and to present this material in suitable form for college students. The book should prove valuable not only to agricultural students studying cotton, but also to teachers in agricultural high schools, agricultural lecturers, graduate students in agriculture, as well as the large and rapidly increasing number of educated southern farmers.

The entrance of the cotton boll weevil into the Cotton Belt brought about marked changes in the common fertilizer and cultural practices followed in the growing of cotton. As the weevil has been only a comparatively short time in the greater portion of the Cotton Belt, production practices have not yet become standardized under weevil conditions, nor have the experiment stations had time to determine entirely to their satisfaction the best practices to follow in the future. Therefore, the author has found it rather difficult in some cases to select out of the mass of conflicting data the most trustworthy information relating to fertilizers and cultural practices under boll weevil conditions. In such cases he has often cited practices followed under non-boll weevil conditions and then given such additional experimental evidence as appeared to indicate the best practices to follow under boll weevil conditions.

The author wishes to acknowledge his indebtedness to his colleagues in other departments of the Clemson Agricultural College and the South Carolina Agricultural Experiment Station, who have read the chapters or portions of chapters that related to their subjects, and who have offered many valuable suggestions. Especial acknowledgement of indebtedness is due to Prof. D. B. Rosenkrans, who read the chapters on the "Morphology of the Cotton Plant" and the "Botanical Classification of Cotton"; to Mr. T. S. Buie, who read the chapters on "Culture of Cotton" and "Fertilizers for Cotton"; to Dr. C. A. Ludwig, who read the chapter on "Diseases of the Cotton Plant"; to Mr. C. B.

Nickles, who read the chapter on "Insects of the Cotton Plant"; to Mr. H. H. Willis, who read the chapters on "Grading and Classification of Upland Cotton" and "Production of American-Egyptian Cotton"; to Prof. C. L. Morgan, who read the chapter on "Feeding Value of Cotton"; and to the author's wife, Hazel Cover Collings, for the patient and helpful criticism which her sympathetic insight, training and experience enabled her to bring to the improvement of the work.

Free use has been made of the publications of the United States Department of Agriculture and the state agricultural experiment stations, as well as those of many foreign stations, for which acknowledgment is due.

GILBEART H. COLLINGS

CLEMSON AGRICULTURAL COLLEGE

May 1, 1926

CONTENTS

CHAPTER I

EARLY HISTORY OF COTTON

PAGES

History of cotton in the eastern hemisphere; history of cotton in the western hemisphere; origin of cotton; references.....	1-2
---	-----

CHAPTER II

CLIMATOLOGY OF COTTON AND ITS RELATIONSHIP TO COTTON PRODUCTION

Sunshine; temperature; frost; rainfall; humidity; uniformity of climatic conditions in the cotton belt; effect of climate upon the cotton lint; Texas cotton; gulf cotton; upland cotton; references.....	3-8
---	-----

CHAPTER III

PRINCIPAL SOIL REGIONS OF THE COTTON BELT

An ideal soil for cotton; universal lack of ideal soils; soils for Sea Island cotton; the relationship of soils to cotton diseases; classification of the soils of the cotton belt; references.....	9-15
---	------

CHAPTER IV

MORPHOLOGY OF THE COTTON PLANT

The roots; the stem; the branches; the leaves; the involucre; the flowers; the bolls; the lint; the linters; the seed; references.....	16-24
--	-------

CHAPTER V

BOTANICAL CLASSIFICATION OF COTTON

The Malvaceae, or mallow family; the genus <i>Gossypium</i> ; number of species of cotton; American Upland cotton (<i>Gossypium hirsutum</i> , L.); Sea Island cotton (<i>Gossypium barbadense</i> , L.); Indian cotton (<i>Gossypium herbaceum</i> , L.); Egyptian cotton; Peruvian cotton (<i>Gossypium peruvianum</i> , Cav.); Bengal cotton (<i>Gossypium arboreum</i> , L.); references	25-30
---	-------

CHAPTER VI

PHYSIOLOGY AND CHEMISTRY OF THE COTTON PLANT

PAGES

The plant cell; size and shape of plant cells; divisions of the plant cell; the cell walls; the protoplasm; essential elements required by every plant; the source of the essential elements; amount of water found in the cotton plant; absorption of plant nutrients from the soil; composition of the cotton plant; photosynthesis; translocation of food in the plant; processes involved in fertilization; references..... 31-35

CHAPTER VII

CLASSIFICATION OF AMERICAN UPLAND COTTON VARIETIES

What is a variety; groups of cotton varieties; the cluster group; the semi-cluster group; the Rio Grande or Peterkin group; the early type or King-like group; the big-boll group; the long-limbed group; intermediate varieties; the long staple upland group; classification of varieties; percentage of lint; shedding of bolls; leading varieties east and west of the Mississippi River; origin of a few characteristic varieties; Dillon; Blue Ribbon; Cleveland Big-boll; King; Toole; Hagaman; Russell; Hartsville; variety tests; some characteristics of our most common varieties; Cleveland; Cook; Deltatype Webber; Hartsville; King; Lightning Express; Rowden; Triumph or Mebane; Dixie; Dillon; varieties of cotton most commonly grown; references..... 36-54

CHAPTER VIII

CULTURE OF COTTON

Time of plowing; preparation of the land for plowing; plowing practices; depth of plowing; sub-soiling; dynamiting; preparation of the seedbed; width of rows; purchase of seed; delinting cotton seed for planting; planting the seed; quantity of seed to plant; comparison of heavy separated seed and unseparated seed; time of planting; early cultivation and chopping; single stalk cotton culture; number of cultivations; side application of fertilizers; value of cultivation; pruning; topping; cultivation of Sea Island cotton; cotton rotations; cultural practices followed in various sections of the cotton belt; references..... 55-80

CHAPTER IX

FERTILIZERS FOR COTTON

The need for lime; the need of nitrogen, phosphorus, and potassium; value of farmyard manure as a fertilizer; nitrogenous fertilizers; phosphatic fertilizers; potassic fertilizers; composition of common materials used in

cotton fertilizers; loss of plant food elements from the soil; how to determine which element is the limiting factor; the effect of nitrogen, phosphorous, and potassium on the growth of the cotton plant; value of fertilizers; use of nitrogenous fertilizers; use of phosphatic fertilizers; use of potassic fertilizers; home mixing of fertilizers; the relation of legumes to the maintenance of nitrogen; do cotton fertilizers pay; the application of cotton fertilizers; references.....	81-102
---	--------

CHAPTER X

DISEASES OF THE COTTON PLANT

Cotton wilt, or frenching (<i>Fusarium vasinfectum</i> Atk.); cotton root knot, or root gall (<i>Heterodera radicola</i> Greef. Mul.); cotton anthracnose, or pink boll rot (<i>Glomerella gossypii</i> Edg.); angular leaf spot (<i>Bacterium malvacearum</i> Erw. Smith); diplodia boll rot (<i>Diplodia gossypina</i> Cooke); Texas cotton root rot (<i>Phymatotrichum omnivorum</i> Shea); black rust of cotton; blue cotton; cotton diseases of minor importance; references....	103-114
---	---------

CHAPTER XI

INSECTS OF THE COTTON PLANT

Some of the minor or less important insects that attack cotton; some of the major or more important insects that attack cotton; the Mexican cotton boll weevil (<i>Anthonomus grandis</i> Boh.); the cotton boll worm (<i>Chloridea obsoleta</i> Hubn.); the pink boll worm (<i>Pectinophora gossypiella</i> Saunders); the cotton leaf worm, or cotton caterpillar (<i>Alabama argillacea</i> Hubn.); the red spider (<i>Tetranychus telarius</i> L.); cotton root louse (<i>Aphis maidi radiceis</i> Forbes); cutworms; cotton dusting machinery; references..	115-143
--	---------

CHAPTER XII

HARVESTING OF COTTON

Time of picking; the picking process; yield of cotton.....	144-148
--	---------

CHAPTER XIII

GINNING AND BALING OF COTTON

Ginning practices; precautions preparatory to ginning; types of ginneries; types of cotton gins; handling of cotton at the ginnery; cotton bales; plated bales; number of cotton ginneries in the United States; references	149-154
---	---------

CHAPTER XIV

WAREHOUSING OF COTTON

PAGES

The value of cotton stored in warehouses; the warehouse capacity of the cotton belt; the distribution of cotton warehouses; standard warehouses; size of warehouses; service rendered to farmers by warehouse corporations 155-157

CHAPTER XV

MARKETING AND TRANSPORTATION OF COTTON

Route from farm to spinner; cotton prices; the selling of seed cotton; the selling of seed and lint; shipping; size and density of bales; amount of cotton exported; cotton markets; kind of markets; time of buying and selling; references. 158-164

CHAPTER XVI

GRADING AND CLASSIFICATION OF AMERICAN UPLAND COTTON LINT

Classification according to grade; classification according to length of staple; classification according to character; references. 165-174

CHAPTER XVII

BREEDING OF COTTON

The results of previous breeding of cotton; the work of the plant breeder; "running-out" of cotton; selection of seed; maintaining and improving the good qualities of cotton; improvement of cotton by selection; type of plant most often sought; characteristics of early, medium, late, rapid, and productive types; characteristics of storm resisting types; characters seldom found together; linkage of characters; work for some definite end; making the selections; necessity of testing out the selected plants; methods of testing out the selected plants; planting of the seed; harvesting the plant-to-row selections; continuation of selection; the improvement of cotton by hybridization; selfing; inheritance of characters; time of crossing; emasculating and crossing; harvesting and selecting; references. . . . 175-191

CHAPTER XVIII

BY-PRODUCTS OF THE COTTON PLANT

Recent development of the cottonseed by-product industry; prejudices against cottonseed oil products; by-products of the cottonseed oil mills; cottonseed meal and soil fertility; oil mills. 192-194

CHAPTER XIX

FEEDING VALUE OF COTTON

PAGES

Feeding value of cotton plants; feeding value of cotton seed; feeding value of cottonseed hulls; feeding value of cottonseed meal; toxic properties of cotton seed and cottonseed meal..... 195-197

CHAPTER XX

COTTON REGIONS OF THE WORLD

Cotton production in the United States; India; China and Chosen; Egypt; Brazil; Russia; minor cotton regions of the world..... 198-200

CHAPTER XXI

HISTORY OF COTTON PRODUCTION IN THE UNITED STATES

Introduction of cotton into the United States; importance of cotton before the Revolutionary War; creation of a demand for cotton; satisfying the demand; cotton mills in the United States; invention of the cotton gin; slavery; the cotton famine; history of cotton manufacture since 1865; history of cotton production from 1865 to 1914; history of cotton production during and immediately after the World War; references..... 201-205

CHAPTER XXII

PRODUCTION OF AMERICAN-EGYPTIAN COTTON

Origin of American-Egyptian cotton; localities of the United States adapted to the production of American-Egyptian cotton; early breeding work with American-Egyptian cotton; maintaining a supply of pure seed; preparation of the soil for American-Egyptian cotton; planting; cultural practices; alkali resistance; picking; ratooning; enemies of American-Egyptian cotton; Arizona wild cotton (*Thurberia thespesioides* A. Gray); land renovating value of American-Egyptian cotton; use of American-Egyptian cotton; grades of American-Egyptian cotton; comparison of the American-Egyptian cotton grades with the American Upland and Egyptian cotton grades; production of the crop since 1912; references..... 206-214

APPENDIX..... 215-248

INDEX..... 249-256

THE PRODUCTION OF COTTON

CHAPTER I

EARLY HISTORY OF COTTON

The history of the cotton plant dates back through authentic history, back through records of semi-authenticity, until it becomes lost in antiquity.

History of Cotton in the Eastern Hemisphere. — The earliest records that we have point to the growth and production of cotton in India. For some unknown reason the Sanskrit poets of dreamy India have eulogized seemingly every other important and useful plant except cotton. From what one might read between the lines of early records, cotton must have been of considerable commercial and agricultural importance for even centuries before these records were written. As to the botanical nature of this early cotton we know very little. In some records it is mentioned as a wild tree of perennial nature, while in other cases one would be led to believe that it was a bush subject to cultivation.

The early Hebrews and Phoenicians were acquainted with the cotton fiber, but as to the place of the production of this fiber we are uninformed.

In the year 800 B.C. we have the earliest authentic mention of cotton, where it is compared with silk and hemp as that of which was made the sacred thread of the Brahman.

The early Greeks, no doubt, were well acquainted with cotton through their explorers, especially those who went with Alexander the Great and his successors into India. It is thought by many that cotton had developed to a considerable extent into an article of commerce between India and Greece long before any true record which we have today was written. Herodotus, in 450 B.C., speaks of the wild trees of India which bear wool, and Theophrastus (350 B.C.) tells something of its cultivation, and also cites that cloth is made from its fiber. Many other records of a later date refer not only to the culture and manufacture of cotton, but also to the trade of the manufactured textiles.

From India cotton was carried to China, more or less as an ornamental plant, at some unknown date, but it was not grown as a fiber crop until about the thirteenth century. Cotton was also introduced into Japan

from India about the year A.D. 781. Later records show cotton in a number of other countries of the Eastern Hemisphere, but it is thought by many that it was originally taken from India. Marco Polo, a traveler through Asia in 1298, refers to the production and also the manufacture of cotton in many countries. He states that India produces "the finest and most beautiful cottons that are to be found in any part of the world." In 1516 Odoardo Barbosa found the inhabitants of South Africa growing the cotton plant and wearing cloth made of its fiber.

History of Cotton in the Western Hemisphere. — In the Western Hemisphere cotton has been grown from the dateless past. Cotton cloths have been found on Peruvian mummies of a very ancient date. Columbus, in 1492, found the inhabitants of the West Indies growing cotton. In 1519 Cortez found the people of Mexico growing cotton and producing cotton fabrics, samples of which were included in the treasures sent back to Charles V. of Spain. Likewise, in 1519 Magellan found cotton growing in Brazil, and in 1522 Pizarro found it growing in Peru. In fact, cotton was found growing from 40° S. latitude to and including Mexico of today. For some unknown reason cotton had not been introduced at this early date into the present confines of the "Cotton Belt."

Origin of Cotton. — It is not known where cotton originated. It cannot even be proven to be a native of either hemisphere. It may have originated simultaneously in both hemispheres, or it may have been carried, through some unknown means, from the hemisphere of its origin to the other. Nevertheless, one thing is known, cotton is a tropical plant, and in its native state is a perennial, and from this we are justified in making the assertion that cotton is a native of tropical or sub-tropical regions.

REFERENCES

1. The Cotton Plant. U. S. D. A., Office of Experiment Station, Bul. 33, 1896.
2. Watt, Sir George. The Wild and Cultivated Cotton Plants of the World. Longmans Green & Co., 1907.

CHAPTER II

CLIMATOLOGY OF COTTON AND ITS RELATIONSHIP TO COTTON PRODUCTION

The successful production of cotton in any of the cotton growing areas of the world is controlled largely by the group of factors which go to make up climate, such as sunshine, temperature, wind, the amount and distribution of rainfall, and humidity. These factors exert a tremendous influence upon the growth of the cotton plant. The extent of this influence depends upon the relationship of one factor toward another, or to the rest of the group, as they combine to make up the climatic conditions of the year. Their effect upon the cotton plant is so great, as we shall see later, that even the quality of the fiber of the same variety of cotton is changed when grown in different sections of the Cotton Belt.

Sunshine. — The Cotton Belt, which is poetically known as the land of cotton, is also the land of sunshine. As an average for the whole Cotton Belt fifty to sixty per cent of the days of the growing season are clear and sunny. Cotton and sunshine go together, for cotton is a sun-loving plant. However, other climatic factors besides sunshine must enter into the production of cotton. Too long a period of continuous sunshine may mean a period of dry weather, which, of course, will hinder the growth of cotton unless water is supplied to the plant by means of irrigation, as is done in the American-Egyptian cotton district of California and Arizona. When the plant is young, short periods of sunshine alternating with short periods of rainfall bring about an ideal condition of growth. When the plant is in full bloom, plenty of sunshine is absolutely essential. After blossoming time the quantity of sunshine does not play such an important part, provided other conditions are ideal.

Temperature. — Cotton is a tropical plant and must have warmth, particularly during the most rapid stages of growth, which come during the latter part of spring, and which extend to about the first of August. After about August first the vegetative growth of the cotton plant should have been completed, and from then on the plant's energies should be directed largely to the production of fruit. It is not sufficient that the plant get a maximum number of hours of sunshine, but the

sunshine must be of such a quality or intensity that the temperature will be raised to an optimum degree for ideal cotton growth. The mean daily temperature should, and does in normal years, increase gradually until the vegetative growth is made, and then decrease gradually from that time on. The old Cotton Belt, which includes nearly all the territory in the United States east of New Mexico and south of 37 degrees latitude, has an average summer temperature of 77 degrees F., or over, and an average temperature for the growing season of 70 degrees or over. Small quantities of cotton are grown where the average summer temperature is less than 77 degrees, but this is of no particular economic importance. The mountaineers of eastern Kentucky, for example, grow small amounts of cotton for their own consumption where the annual summer temperature is only about 74 degrees. In the southern part of the Cotton Belt the average summer temperature runs between 80 and 85 degrees, while the American-Egyptian cotton district of the Imperial Valley of California has an average summer temperature of 95 degrees.

Frost. —The last killing frost in the spring in the northern part of the Cotton Belt is about April 10, and the first killing frost in the fall about October 25. This gives the growers of this section 200 days free from the dangers of frost for cotton production. Cotton requires six months of warm weather and four to five months of uniformly high temperature. In the southern part of the Cotton Belt the last killing frost in the spring is about March 10, and the first killing frost in the fall about November 25, or just one month earlier in the spring and one month later in the fall, giving the southern grower sixty more days, or a total of 260 days for cotton production. Where conditions are normal the highest average yields are made in sections with over 200 days free from frost.

The late frosts in the spring rarely cause any damage, for the cotton grower has learned through experience with past conditions that it does not pay to plant cotton too early in the spring. However, since the coming of the cotton boll weevil the farmers have been urged to get an early start. This may easily be overdone, and in such cases considerable losses from late frosts may be brought about. Under non-boll weevil conditions as in western Texas, early frosts in the fall may cause considerable damage, particularly to late cotton, for they always kill the young vegetation and the immature bolls. The more nearly matured of the bolls may open, but if the temperature has been sufficiently low to kill them the grade of the fiber produced will be poor.

When the cotton plant is young, cool nights, although not sufficiently cold for frost, injure, dwarf, and delay growth.

Rainfall. — The rainfall over the entire Cotton Belt, as might well be expected for so large an area, is extremely varied. The average annual rainfall in western Oklahoma and Texas is about 23 inches, — and this district marks the western limit of the Cotton Belt, — while in southern Mississippi it is about 60 inches, and in eastern North Carolina about 50 inches. The average annual rainfall for the greater part of the Cotton Belt will run from 30 to 50 inches. However, the average annual rainfall has not as much effect upon the quantity and quality of lint produced as has the distribution of the rainfall.

The spring rainfall is heavier in the Mississippi Valley than in the South Atlantic States, and heavier in the South Atlantic States than in west Texas and Oklahoma. The rainfall during the summer, as an average for the entire Cotton Belt, is heavier than at any other period. The greatest portion falls in the southeastern part, and the least in the southwestern part of the Cotton Belt. August is the wettest month in North and South Carolina; March in the Mississippi Valley, Alabama, and North Georgia; and May in Texas and Oklahoma. Autumn, being the driest season for the entire Cotton Belt, presents ideal conditions for the harvesting of cotton.

Excessive rainfall, together with cool weather just after planting, will prevent germination and cause the seed to rot. Light, frequent showers are desired at this time. A cold, wet spell just after the cotton is up is very unfavorable as the processes of growth are delayed. Heavy rains during May and June interfere with cultivation, cause the production of shallow roots, and if followed by a dry spell in July and August result in the wilting of the plant and the shedding of the bolls and leaves. There is a trite saying among farmers that "a dry May produces a clean crop." Cool spells during July may cause the suspension of the vegetative growth before it should be stopped, and thus cause early fruitage. It is preferable that the showers during June and July should come during the night so that the plant may receive a maximum amount of sunlight during the day. Heavy rainfalls during July and August have a tendency to increase the vegetative growth with consequent decrease in the number of bolls and a delay in maturity. Excessive rains during September and October interfere with picking, and reduce the quality of cotton, particularly if accompanied by high winds. After August first two or three months of cool and comparatively dry weather are desirable. The average rainfall for the picking season over the entire Cotton Belt is less than 12 inches, and mostly under 10 inches.

Very little cotton is grown along the coast east of Galveston, Texas,

and practically none in Florida, partly because of sand and swamp areas, but more particularly because of heavy fall rains.

An ideal season for cotton production is a warm spring with frequent rains of a light nature, followed by a medium moist summer. The rains should be preferably of the thunderstorm type, and at night. The fall season should be cool and dry. The maximum stalk growth should be made by the first of August.

Humidity. — The quantity and frequency of rainfall determine to some extent the degree of humidity. Likewise, the distance from large bodies of water influences the humidity. The degree of humidity is very closely related to the presence of, and the damage done by, fungous diseases. The humidity is highest during the growing period in the southern part of the Mississippi Valley, and the damage done by fungous diseases in this section is greater than in any other part of the Cotton Belt. Sea Island cotton and some varieties of Upland appear to do better in humid sections. Sea Island, for this reason, is not grown very far inland, the largest sections being near the seacoast of South Carolina, Georgia, and Florida, and on adjoining islands.

Uniformity of Climatic Conditions in the Cotton Belt. — The Cotton Belt is so large, and its climatic conditions so varied, that it becomes very improbable that there should ever arise a complete failure of cotton throughout the Cotton Belt due to climatic conditions alone. As a general thing, when one section suffers because of injurious climatic conditions another section has normal climatic conditions. For this reason the average yields of cotton are more uniform, when extended over a period of twenty to thirty years, than those of any other American crop.

Effect of Climate Upon the Cotton Lint. — The effect of climate upon the cotton staple is so great that American Upland cotton from the different sections of the Cotton Belt can oftentimes be detected by the grader, and is often given regional names. While these regional names are numerous, they can roughly be classified into three great groups called the Texas, Gulf, and Upland cottons. The term Upland, as applied to a regional group, is rather confusing to the uninitiated, because of the fact that the name of the group and the common name of the species to which the group belongs are the same. As we have already seen, Sea Island cotton is confined to sections of the Cotton Belt of a definite humidity.

Texas Cotton. — Texas cotton is a trade name given to most of the cotton produced in Texas and Oklahoma. It belongs to the American Upland species of cotton and averages from $\frac{7}{8}$ to $1\frac{1}{8}$ inches in length. The character of this cotton varies from year to year, depending upon

the climatic peculiarities of the season in which it was grown. As a general rule the cotton has a heavier body, that is, larger in diameter and heavier in weight, than the cotton from the Gulf and Upland sections, and for this reason is superior for spinning. Dry seasons produce a cotton fiber that is shorter than usual and which is somewhat harsh, that is, a fiber containing very little water and oil. In fact, cotton fiber produced in non-irrigated regions and in climates which are dry and hot always has a tendency to harshness. The leaves of the cotton plant in the Texas region tend to dry up early and the leaf which becomes mixed with the cotton is lighter, more broken, and peppery than the leaf in the cotton from the other two regions. The larger the leaf the easier it is for the spinner to separate it from the lint. Large quantities of leaf, boll hulls, broken stalk, and shale, which is the membraneous lining of the boll, also are found in this cotton. Bolls which become dried up on account of drought, and which were not mature enough to open naturally, are picked, ginned, and the fiber sold as "bollies." These fibers are of a bright yellowish color and softer and more fluffy than the ordinary mature staple. Another type called "snapped," or "machined" cotton is made from cotton taken from immature and open bolls which are gathered, burs and all, by machinery at the end of the season. This fiber resembles very much "bollies" but is a superior fiber and can be graded in the usual way.

Gulf Cotton. — The term Gulf Cotton is used to designate cotton which is grown in the states of the Mississippi River basin bordering the Gulf of Mexico. The cotton of this region averages in length from $1\frac{1}{16}$ to $1\frac{1}{8}$ inches. Some of the long staple cottons from other sections of the Cotton Belt are sometimes wrongly classified as Gulf cotton because of their length. The staple of this cotton is whiter and the leaf in the lint is larger and of a blacker color than cotton from the other two groups. Another trade name for this cotton is Orleans, but neither Orleans nor Gulf is used as extensively as such specific names as "Canebrake," "Benders," "Peelers," "Rivers," "Creeks," and "Red River," which refer to the cotton from specific sections of this region.

"Canebrake" cotton is grown on the black prairie soils of south central Alabama. It has a $1\frac{1}{16}$ inch staple and brings a higher price than any other Alabama cotton. Soil conditions play a greater part in this case than the climatic factors in determining the quality of the lint.

"Benders" grow on the River Flood Plains of the Mississippi, Arkansas, and White Rivers. This name was originally applied to the cotton grown in the bends of the Mississippi River. The staple averages from $1\frac{1}{8}$ to $1\frac{3}{16}$ inches in length.

“Peelers” is a name formerly applied to a particular variety of cotton, but now applied to all the cotton grown in the Mississippi delta. The staple of this cotton averages about $1\frac{1}{4}$ inches.

“Rivers” is a name applied to cotton grown on bottom land, which ranges in length from $1\frac{1}{8}$ to $1\frac{3}{16}$ inches, and is medium bodied. Lighter bodied staple grown on bottom land is often referred to as “Creeks.”

Upland Cotton. — Upland, as a regional name, is applied to cotton that is grown in Virginia, North Carolina, South Carolina, Georgia, Alabama, Tennessee, and in parts of Mississippi, Louisiana, Arkansas, and Texas. Like the Texas and Gulf Cottons, it belongs to the American Upland species. The fiber will vary from $\frac{7}{8}$ to 1 inch in length. In the Sand Hill sections of North Carolina, South Carolina, and Georgia, and in the Coastal Plain Province the staple is often less than $\frac{7}{8}$ inch in length, while in the Piedmont Province the length may often exceed 1 inch. The cotton of the Coastal Plain Province has a dead white appearance and the leaf found in the lint is large and light in color. Cotton grown in the Piedmont Province has a bright, creamy color or “bloom” and is much desired by the spinners. Because of the greater rainfall, cotton of the Upland region when left in the field changes color faster than the cotton of the Texas region.

REFERENCES

1. Ewing, F. C. A study of certain environmental factors and varietal differences involving the fruiting of cotton. Mississippi Exp. Sta., Tech. Bul. 8, 1918.
2. Cotton. U. S. D. A., Atlas of American Agriculture, Part V, Sec. A, 1911.
3. The Cotton Plant. U. S. D. A., Office of Experiment Station, Bul. 33, 1896.

CHAPTER III

PRINCIPAL SOIL REGIONS OF THE COTTON BELT

The physical, chemical, and biological characteristics of the soil influence the yield of cotton just as they do the yield of any other crop. Sandy soils, which contain very little organic matter, produce very light yields of cotton. Silty loams and clay loams give the best yields, but where large amounts of organic matter are present, or where large applications of nitrogenous fertilizers have been made, the cotton plant makes an excessive amount of vegetative growth. This is particularly true when heavy rainfall occurs during the growing season. An excessive vegetative growth checks the production of bolls, and thus lowers the yield. Uplands, because of their lack of fertility, produce small plants and consequently small yields. This lack of fertility brings about an early maturity, but, of course, yield should not be sacrificed for early maturity. Bottom lands and the Black Prairie soils of central Alabama produce large plants because of their high nitrogen content, but the maturity of cotton grown on these soils is much delayed.

An Ideal Soil for Cotton. — An ideal soil for cotton is one which is well drained, and which contains about equal proportions of sand, silt, and clay, together with a considerable amount of organic matter. While it should be well drained, it also should be a storehouse for moisture. For optimum growth conditions the soil should have about 60 per cent of its pore space filled with water and 40 per cent with air.

Universal Lack of Ideal Soils. — Very few soils of the Cotton Belt are ideal for cotton production: either they are too dry or too wet, too poor or (in exceptional cases, as on bottom lands) too rich for maximum production. A very rich soil is not desired for cotton, as is the case with corn, but a soil of medium fertility gives the best results. Soils which are too wet may be drained; soils which are too dry, as those located in arid or semi-arid regions, must be abandoned as far as cotton production is concerned, or supplied with water through irrigation; poor soils may be made more productive by means of commercial fertilizers. Each soil type presents peculiarities of its own, and its treatment will vary in accordance with the varying conditions presented. However, a profitable crop of cotton can be made, under the present economic conditions, with the application of scientific methods of farming, in nearly all sections of the Cotton Belt.

Soils for Sea Island Cotton. — The soil requirements for the Sea Island species of cotton are somewhat different from those of the Upland. While the Upland species does best on clay or silt loams, the Sea Island does best on sandy silts. However, Sea Island will not grow well on all sandy silts of the Cotton Belt, but appears to be adapted only to the sandy silt soils of regions of a certain humidity.

The Relationship of Soils to Cotton Diseases. — Cotton grown on some types of soils seems to be more susceptible to disease and insects than cotton grown on other types. Cotton grown in the Sand Hill belt, or on sandy soils of the Coastal Plain, is very susceptible to cotton rust. In this case there seems to be some connection between the potassium content of these soils and the degree of injury done by the rust. All of these soils are low in their potassium content. Bottom lands are quite often affected to a greater extent by both diseases and insects than neighboring uplands.

Classification of the Soils of the Cotton Belt. — The Bureau of Soils, of the United States Department of Agriculture, in *Atlas of American Agriculture*, Part V, Section A, page 8, classifies the soils of the Cotton Belt into the following regions:

“ Important Soil Regions of the Coastal Plain

“ Atlantic Coast Flatwoods: — This region extends along the coast of the Carolinas and Georgia into Florida. Area, 21,200,000 acres. Elevation, 0 to 150 feet. Surface, flat to undulating; much poorly drained land and swamp. Soils, mainly dark and grayish sands and sandy loams, with yellow, gray, and mottled sand and clay subsoils; considerable silt loam in northeastern North Carolina. Vegetation, principally open forests of longleaf pine, with gallberry and grassy undergrowth. Fertilizers are extensively used. Average yield per acre of lint cotton is about 200 pounds; average production, 290,000 bales.¹

“ Florida and Southern Mississippi Flatwoods: — Area, 15,000,000 acres. Mainly dark and grayish to white, deep sandy soils. Vegetation, chiefly long-leaf pine, with saw palmetto undergrowth. Little cotton is grown in this region.

“ Middle Coastal Plain: — This region extends across the Carolinas and Georgia into western Florida. Area, 20,600,000 acres. Elevation, mostly between 100 and 400 feet. Surface, gently rolling. Soils, mainly grayish sandy loams with yellow, friable sandy clay subsoils. Vegetation, long-leaf pine and wire grass. Yield of cotton per acre,

¹ Figures of the average yield per acre of lint cotton are for the four census years 1879, 1889, 1899 and 1909, unless otherwise noted. These are the only years for which statistics of acreage by counties are available. Figures of the average production are for the five years 1911–1915.

about 205 pounds; production, 1,140,000 bales, owing largely to the use of fertilizer.

“ Upper Coastal Plain: — This region extends from South Carolina across central Georgia and southern Alabama into central Mississippi, and includes a portion of northern Florida. Area, 28,700,000 acres. Elevation, 20 to 500 feet. Surface, rolling. Soils, mainly grayish and reddish sandy loams with yellow and red, friable, sandy clay subsoils. Vegetation, long-leaf and short-leaf pine, some oak and hickory. Yield of cotton per acre about 190 pounds; production, 1,130,000 bales. Much fertilizer is used.

“ Clay Hills: — This region extends from western Georgia through Alabama and Mississippi almost to the Tennessee line. Area, 8,000,000 acres. The soils have stiff clay subsoils, and the surface is hilly, including some rough stony land known as ‘ white rock land ’ in east-central Mississippi and western Alabama. Average yield of cotton per acre is about 145 pounds; average production 320,000 bales.

“ Sand Hills: — This region extends in a narrow, interrupted belt along the upper margin of the Coastal Plain from central North Carolina across South Carolina and Georgia into Alabama. Area, 3,400,000 acres. Soil prevailingly deep, loose sand, grayish at the surface and yellowish beneath. Vegetation, long-leaf pine and forked leaf blackjack oak. Fertilizer is extensively used. Average yield of cotton per acre is about 180 pounds; average production, 175,000 bales.

“ Black Prairies: — This crescent shaped belt extends from eastern Alabama into northeastern Mississippi. Area, 4,000,000 acres. Elevation 200 to 500 feet. Surface, gently rolling with some flat ‘ post oak land.’ Soils, mainly dark gray and brown, limey clays. The included ‘ post oak ’ soils are brown sandy loams and clays, with reddish subsoils and contain less lime. Yield of cotton per acre is less than 150 pounds, owing largely to continuous cropping and shallow plowing; production, 235,000 bales.

“ Mississippi Bluffs and Silt Loam Uplands: — This region borders the Mississippi bottom lands on the east, and extends from Louisiana into Kentucky. Area, 16,800,000 acres. Elevation, 100 to 600 feet. Surface level to undulating, badly gullied in places. Soils mainly brown silt loams of loessial origin, becoming thinner along the eastern border. A narrow strip of the same soil occupies Crowley’s Ridge, extending from southeastern Missouri to Mariana, Arkansas. Vegetation, principally oak, sweet gum, and poplar. Yield of cotton per acre about 200 pounds; production, 586,000 bales.

“ Interior Flatwoods: — The largest area of the Interior Flatwoods extends from the Mississippi bottoms in Louisiana to the Guadalupe River in Texas. A long, narrow, crescent-shaped belt extending from central Alabama into northeastern Mississippi has similar soils and topography. Area, 13,000,000 acres, including about 600,000 acres in Alabama and Mississippi. Elevation, 100 to 500 feet. Surface, prevailingly flat; much poorly drained land. Soils, mainly gray sandy loams, silt loams, and clays with compact gray and yellow or mottled subsoils. Vegetation, long-leaf pine in Louisiana and eastern Texas;

post oak in central Texas, Alabama, and Mississippi. Yield of cotton per acre, about 175 pounds; production, 366,000 bales.

“*Interior Coastal Plain*:— This region comprises a large area of prevaillingly rolling country in northeast Texas, northwest Louisiana, and southwest Arkansas. Area, 28,800,000 acres. Elevation, 100 to 500 feet. Vegetation, in the east, long-leaf and short-leaf pine and some oak; in the west, oak with some prairie areas. Soils, mainly grayish, brownish, or reddish sandy loams, sands and clays having in Area *A* much soil with yellow, red, and mottled friable sub-soils, and in Area *B* relatively more soil with gray and red mottled stiff clay sub-soils. Section *A* produces an average of about 165 pounds of cotton per acre, and section *B*, 163 pounds. The total production averages 995,000 bales.

“ ‘*Black Waxy*’ *Prairies*:— There are two main bodies of these prairies, one extending from the Red River in northeast Texas to San Antonio, and the other from the Brazos River nearly to Laredo. Area of the first about 8,400,000 acres, of the second about 4,900,000 acres. Elevation, 100 to 600 feet. Surface, flat to undulating; drainage, good. Soils, black and dark gray calcareous clays. There is a small belt of similar soils in southeastern Oklahoma and southwestern Arkansas. Average yield of cotton per acre about 175 pounds; average production, 1,300,000 bales.

“ Less important soil regions of the Coastal Plain are the sandy rolling lands of interior Florida, which contain some red and brown loamy hammock lands, where Sea Island cotton is sparingly grown; the Appalachia Border of the Coastal Plain in northern Alabama and northeastern Mississippi, a region of rolling to hilly, grayish sandy loams with yellow and red sub-soils, supporting mixed pine and oak forests; the Pontotoc Ridge in Mississippi, which has soils similar to those of the Upper Coastal Plain; and the Gulf Coastal Prairies of Louisiana and Texas, which is a flat, imperfectly drained region of black, brown, and gray clays and loams with black, yellow, and gray mottled clay sub-soils, limey in the western portion. The eastern portion of the Coastal Prairies is largely devoted to rice and the western portion principally to grazing and to corn growing, with cotton ranking second in importance. The Red Lands of Southwest Texas produce some cotton in the northern portion. The soils are mainly reddish sandy loams, gravelly loams, and loams with red sub-soils.

“ *Alluvial Soil Regions*

“ *Alluvial Bottoms of the Mississippi and other Rivers*:— This region includes as the principal area the bottoms of the Mississippi River from Cairo, Illinois, to the Gulf. It also includes the bottoms of all other rivers within the Cotton Belt, many of which are too small to show on the map. Much of the land is subject to overflow, requiring protection by levees. Area, about 16,500,000 acres. Elevation, 0 to 300 feet. Surface, level. Soils of the Mississippi bottoms mainly brown or mottled clays, silt loams, and fine sandy loams with gray, light brown, and mottled sub-soils. Vegetation, largely cypress, red gum, and oak.

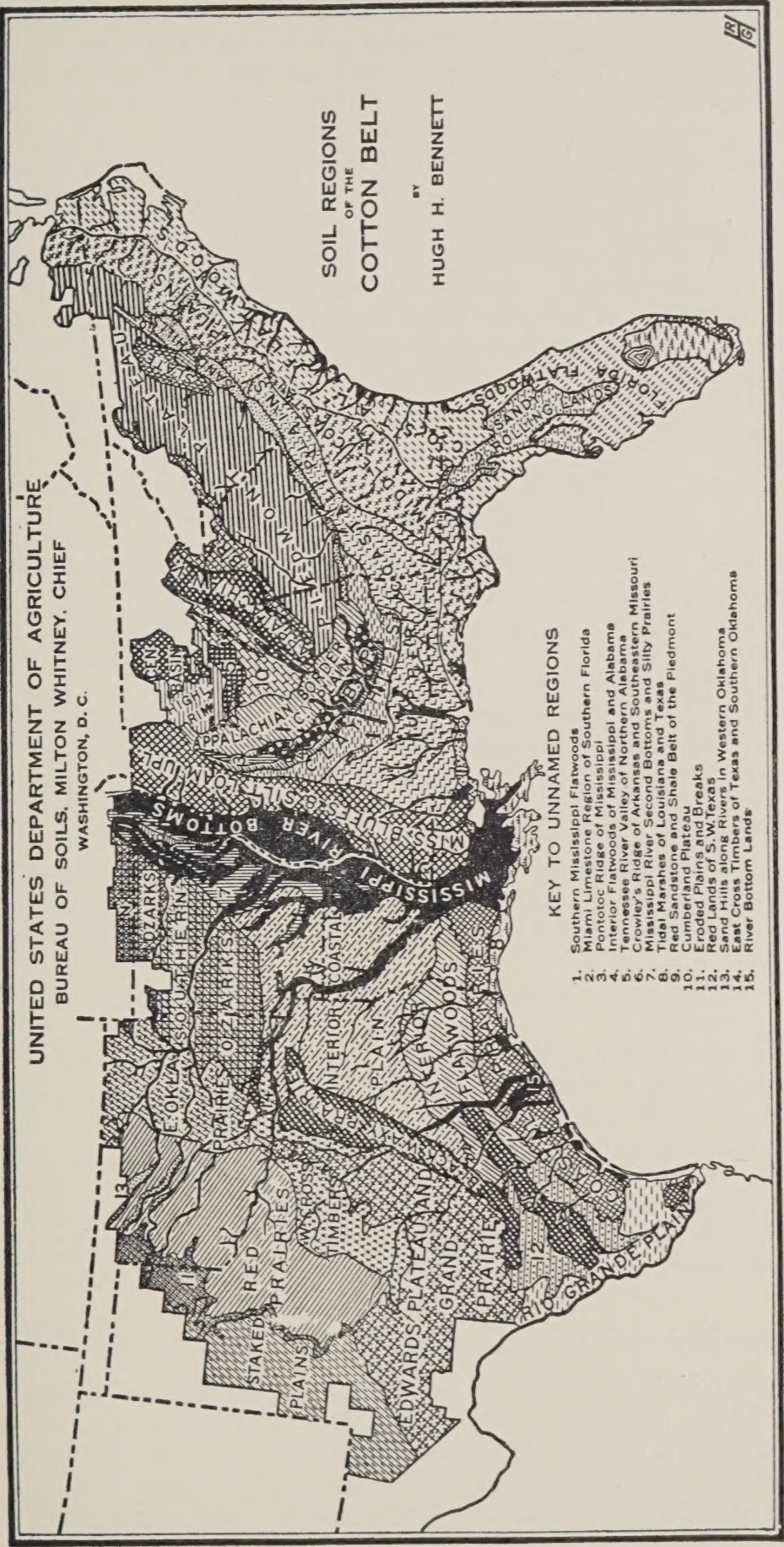


Fig. 1. — Soil regions of the cotton belt. (Courtesy, Bureau of Soils, U. S. Dept. of Agriculture.)

Production of cotton about 940,000 bales. The most important cotton growing section in this region is that known as the Yazoo Delta, in which the average yield of cotton per acre is about 265 pounds, the highest in the Cotton Belt. In the bottoms of the streams east of the Mississippi River the principal soils are brownish loams, silt loams, and fine sandy loams, with yellowish and mottled sub-soils; west of the Mississippi the principal soils are chocolate-red, brown, and black loams, silt loams, and clays, usually calcareous.

“Mississippi River Second Bottoms and Silty Prairies:— These second bottoms are extensively developed in southeastern Missouri and northeastern Arkansas. They lie above overflow. The important soils are brown and gray silt loams, and fine sandy loams with light brown, gray, and mottled sub-soils. The gray soils are poorly drained. The better drained soils are extensively used for cotton, giving good yields.

“Important Soil Regions of the Piedmont, Appalachian, and Ozark Plateaus, Mountains, and Valleys

“Piedmont Plateau:— This region extends from near New York City southwestward to Alabama, but is planted in cotton only from North Carolina southward. Area in the Cotton Belt, 26,700,000 acres. Elevation, 100 to 1500 feet. Surface, rolling to hilly, often requiring terracing of cultivated slopes to prevent erosion. Soils, red clay loams and grayish sandy loams with red or yellow clay sub-soils, derived principally from granite, schist, and diorite. Vegetation, largely oak, short-leaf pine, and hickory. Average yield per acre of cotton, about 180 pounds; average production, 1,860,000 bales. Fertilizer is extensively used.

“In the Carolina Slate Belt portion of the Piedmont the principal soils are gray silt and slate loams and red clay loam, with yellow and red clay sub-soils. Fair to good yields of cotton are made, according to fertilization.

“Less important cotton regions are the Appalachian Limestone Valleys, including the Tennessee River Valley of northern Alabama, and the Central Basin in Tennessee. These are regions of fertile, brown, reddish, and gray loams, silt loams, and clay loams with reddish and yellowish sub-soils, largely derived from limestone and often cherty. A little cotton is grown in the southern portion of the Highland Rim region, which has gray silty and stony soils; and also in the valleys and smooth uplands of the Southern Ozarks of Arkansas and eastern Oklahoma, which is a hilly to mountainous region having brownish or reddish sandy loam soils, often stony, with red sandy clay sub-soils.

“Important Soil Regions of the Western Prairies and Plains

“Eastern Oklahoma Prairies:— This region extends northward from the Red River in south-central Oklahoma, and includes most of the eastern half of the State. It is used principally for corn and hay and for grazing cattle. Area in Cotton Belt, about 11,000,000 acres. Elevation, 800 to 1200 feet. Surface, gently rolling, and some rough areas.

Soils, mainly brown, black, and reddish loams, clays and stony loams with clay sub-soils, often of a clay-pan nature. Vegetation, prairie grasses with occasional areas of post and black-jack oak and red cedar. Yield per acre of cotton in 1909 was 182 pounds; average production, 350,000 bales.

“*Red Prairies*: — This region extends across western Oklahoma into north-central Texas, and is largely devoted to grazing, but has recently experienced extensive development in cotton production. Area, 31,700,000 acres. Elevation, 1000 to 2000 feet. Surface, undulating to rolling, with many rough eroded areas known as ‘breaks’ along the western margin. Soils, mainly red and brown fine sandy loams, silt and clay loams, with red and brown clay sub-soils, often of a clay-pan nature.

“Included in this region are small ‘sand hill’ areas (dunes). Yield per acre of cotton in 1909, 105 pounds; average production, 825,000 bales.

“*Edwards Plateau and Grand Prairie*: — This region extends from central Texas westward to the Rio Grande River, but only the eastern portion is extensively used for the production of cotton. Area of portion east of the Colorado River, 7,400,000 acres. Elevation of this eastern portion 1000 to 2000 feet. Surface, rolling to hilly with some level lowlands. Soils, mainly calcareous silt and clay loams, black, brown, gray, and red in color. Vegetation, largely prairie and plains grasses with scattered post oak and cedar. Average yield per acre of cotton in eastern portion about 115 pounds; average production, 410,000 bales.

“Less important regions of the East and West Cross Timbers in north-central Texas. The soils of both regions are mainly brown sandy loams, often stony, with reddish and yellowish sub-soils. Vegetation, mostly post and black-jack oak. These regions are used largely for grazing cattle, but produce some cotton.”

REFERENCES

1. Atlas for American Agriculture. U. S. D. A., Part V, Section A, 1917.
2. Earle, D. E., and Taylor, Fred. Classification of American Upland Cotton. U. S. D. A., Farmers' Bul., 802, pp. 14-18, 1917.

CHAPTER IV

MORPHOLOGY OF THE COTTON PLANT

The mature cotton plant ranges in height from two to ten feet, depending upon the species, the variety, and the vigor of the plant. It is under tropical conditions a perennial plant, but the winters are sufficiently cold over the greater part of the Cotton Belt to kill it each fall, and for this reason it is looked upon by most people as an annual. In the extreme southern part of the Cotton Belt new shoots appear every spring from the old roots of the previous year, and in this way individual plants may live a number of years. In tropical climates the plant acts as a true perennial, living a number of years, and producing a crop for three or four years after planting.

The Roots. — The entire root system of the cotton plant may be divided into two groups: the primary root, and the secondary roots. The primary root, or tap-root as it is sometimes called, is no more than the continuation of the stem for some distance, usually one to four feet, below the surface of the ground. The depth to which it will descend will depend upon the variety of cotton, the height of the water table in the soil, and the physical and chemical composition of the soil. Balls, working under Egyptian conditions, was able to trace a cotton root to a depth of about eight feet.

The primary root serves the plant as a strong anchor, and as a means of securing water from the deeper soil layers, particularly during times of drought. The secondary, or feeding roots, are small, many-branched, and grow in all directions from four vertical grooves on the tap-root about two inches below the surface of the ground. One of these grooves is found on each quarter of the tap-root.

The secondary roots multiply and form copious networks in the surface soil. Their function is primarily to secure food and water from the soil, and incidentally to act as supplementary anchors for the plant. As the surface four to six inches of the soil is the richest part of the soil, we naturally find here the greatest number of roots. Some cottons, particularly the Egyptian cottons, often send out underground shoots. These shoots also have their origin in the same grooves as the secondary roots.

The roots, which are easily visible to the naked eye, are not able to

extract plant food from the soil. They act only as passageways or channels through which food is conveyed to that part of the plant above ground. Water and other substances are taken from the soil by organs of almost microscopic size known as root hairs, which are found on the very fine roots. These root hairs are no more than the individual cells of the epidermis of the finer roots which have been extended out at approximately right angles to the root in the form of hairlike projections.



FIG. 2. — Newly planted cotton field, with sprouts from over-wintered cotton roots. (Courtesy, U. S. Dept. of Agriculture.)

Being individual cells, they are separated from the soil solution only by a very thin wall, through which the substances in the soil are readily taken up and then conveyed by way of the roots to the other parts of the plant. These root hairs occur in greatest numbers just back of the growing point of the root. Their life cycle is very short, as they soon die and are sloughed off, and new individuals take their place. Very few are found back of two to three inches from the growing point. The bark found on the older roots has a reddish-brown appearance due to the presence of a red resin. It is claimed that this red resin contains a chemical compound similar to that which is found in ergot of rye.

The Stem. — The cotton stem is stout, erect, and cylindrical. At the surface of the soil a mature plant may be from one-fourth to one inch in diameter. It varies in height from one to eight feet, being profusely

branched in some varieties. It is hollow, containing a large white pith. The wood surrounding this pith is soft, brittle, and easily decays when it is plowed under. Unlike the stalks of corn, the stems of cotton offer very little resistance to the cultivation of the land the spring following the growing of the crop. The wood is surrounded by a tough bark which varies in color from a light green to a reddish-brown. The green color is due to the presence of chlorophyll, the substance that gives the green color to the leaves. The brownish or reddish color may be due partly to the presence of a red resin, and partly to a substance known as anthocyanin. It has been observed that this reddish color increases on the stems with age, and that the approach of this red color to the terminal buds shows that growth is being checked. Where cotton is grown under irrigation this red color should be kept three to four inches from the terminal bud, by means of proper irrigation.

The Branches. — The branches arise at the nodes of the stem. Those that arise near the base of the stem are usually the longest, and those that arise near the apex are the shortest. This method of growth gives to the plant a more or less conical shape. The branches and leaves have a regular arrangement in spirals. The normal arrangement in the Upland, Sea Island, and Egyptian species of cotton, and closely related species, is in three-eighths spirals. Old World cotton, on the other hand, has the branches and leaves in one-third spirals. The direction of the spirals on the limbs may be opposite to that on the stem. The length of the branches, and the number and method of sub-branching, will depend largely upon the variety. What has already been said in regard to the color of the bark, and to the readiness with which the stem decays, can also be said of the branches. Both the stem and the branches are more or less covered with fine hairs and numerous dark green spots, which are glands. It is in such glands that the red resin already spoken of has its origin. The branches may be divided into two general groups: (1) fruiting branches, or branches which produce few leaves and many bolls; and (2) vegetative branches, or branches which produce few bolls and many leaves. From the axil of each leaf on the young plant are usually thrown out two buds which may develop into a fruiting branch and a vegetative branch. In some varieties the tendency is for the fruiting branches not to develop, the plant going to "weed," which results in very little seed cotton being produced. In the best yielding varieties the vegetative branches are the ones lacking development. The vegetative branches may also be divided into two groups: (1) fruiting vegetative branches — those branches which arise from the main stem and which produce sub- or secondary branches which bear fruit; and (2) sterile vegetative branches — those branches which do

not produce fruiting sub-branches, but only aid in increasing the leaf area of the plant.

The Leaves. — The leaves of the cotton plant are palmate, petioled, and are arranged spirally on the branch. The first leaves are somewhat heart-shaped, resembling the first leaves of beans, but following these, leaves are developed that are three, five or seven lobed, and three, five or seven veined. Near the base of the mid-vein, on the under side of

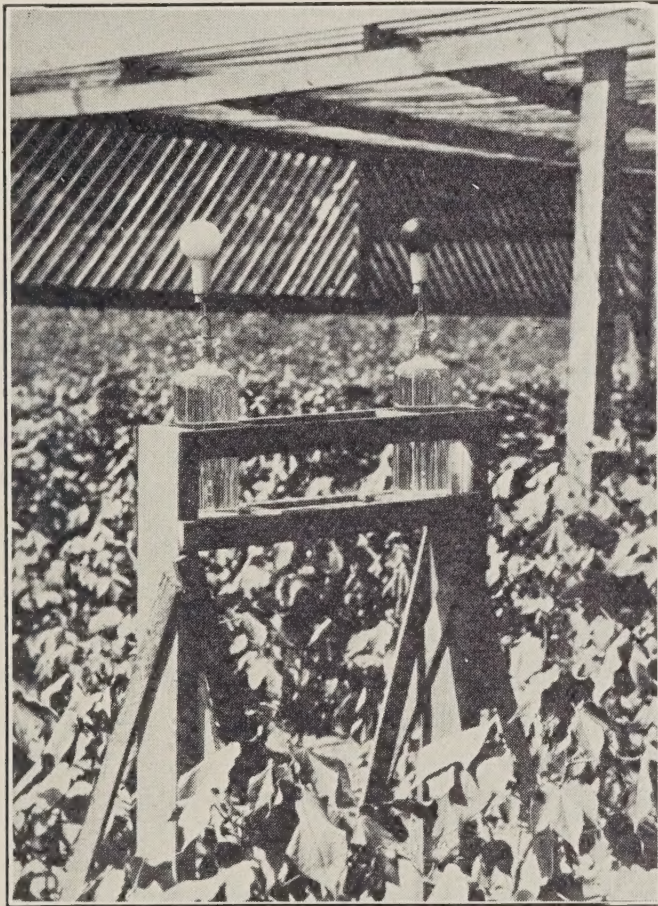


FIG. 3. — Apparatus used in connection with transpiration studies of cotton. (Courtesy, South Carolina Experiment Station.)

the leaf, may be found a small, dark green gland. These glands may or may not be present on the other veins. Monie states that on warm days these glands “discharge any excess of the resinous matter which circulates through its branches.” The size of the leaf will vary, depending upon four factors: (1) the variety of cotton; (2) the position of the leaf on the stem; (3) the vigor of the plant; and (4) the age of the leaf. A full grown leaf will vary in size from three inches in length and two inches in width to seven inches in length and five inches in width. Those leaves that are favorably situated on the plant as to food supply and light develop into larger leaves than those that are not so favorably

situated. In fact, those leaves that become crowded and cut off from the light soon turn yellow, die, and fall from the plant. The leaves of a healthy, vigorous plant will naturally develop into larger organs than will the leaves of a plant that has always been stunted. The color of the leaf will vary from a brownish-red to a light green, depending upon the vigor of the plant and the variety. The green color of the leaf, as is the green color in all green leaves, is due to the presence of chlorophyll, — a green coloring material that has already been mentioned as being present in the stem and branches. This substance is absolutely essential to photosynthesis. The reddish-brown appearance of some leaves is due to a layer of a colored cell sap, which overlies the green chlorophyll. This coloring matter in the sap is called anthocyanin. The leaves are covered with fine hairs similar to those that cover the branches and stems. The leaves exhibit a phototropic or "sleep" movement. They droop down soon after sunset, until the lamina are vertical, and resume their normal attitude in the early hours of the morning.

The Involucre. — Just at the base of the flower are found three, — and always three, — small leaflike bracts. Two of these are of equal size and one smaller. The smaller one is always found on the outer or distal side of the flower. Since these leaflike bracts close around the square and the young boll, they are thought to be a great protection to the boll from storms. On the other hand, the space between these bracts and the boll offer excellent hiding places for such insects as the boll weevil. Occasionally in American Upland cotton two bractlets occur, one on each side of the smallest bract. In some Central-American cottons a bractlet appears on each side of each bract, making six in all. The teeth of all bracts, if twisted, follow the same direction as the overlapping of the petals. When cotton picking time occurs these bracts become brown, crisp and brittle, and being in such close proximity to the lint a large amount becomes mixed with the lint during the process of picking. These broken pieces make up by far the larger part of the trash or leaf ordinarily found in the lint.

The Flowers. — The flowers of cotton are large and resemble very much the flowers of the hollyhock and okra. They are attached to the branches at the nodes accessory to the petioles by short stems called peduncles. The first blossoms appear in about seven to ten weeks after planting. The flower buds or squares may be distinguished three to four weeks previous to the opening of the flower. The South Carolina Station found that squares formed in June and the first part of July develop more rapidly than those formed later in the season. The earlier developing squares reached the flowering stage in from twenty-one to twenty-four days, while those forming in August required twenty-

seven days to reach the flowering stage. The number of flowers produced per plant will depend upon the size of the plant and the variety. If all the flowers be cut off as soon as they open, the plant is stimulated to produce a larger number of flowers during the latter part of the season. The flowers open just before, or at sunrise, and close at night never to open again. Generally speaking, the opening of flowers on the plant follows a spiral course, commencing at the innermost flower of the lowest fruiting branch and ending at the outermost flower of the youngest fruiting branch. The flowers vary in color from white, through a cream or yellow, to a reddish-purple, depending upon the age of the flower and the variety of the cotton. The petals of some varieties, such as the King, are white with a red spot near their base. This portion of the petals is often called the claw. The corollas always turn dark with age, even the white ones becoming by the second or third day after opening, a reddish-purple hue. There are five sepals, which are united. Occasionally small flaplike intracalicular organs, supposedly supernumerary calyx lobes, are found inserted between the calyx and the petals. The petals number five also, and may or may not be united at their base. Two are large, two small, and one is intermediate. The stamens are numerous and are arranged in five vertical rows on the staminal column. The column is made up of the united filaments of the stamens. Great quantities of pollen are produced, there being as many as 80 or 90 anthers produced in some flowers. The pollen appears as a heavy, sticky, yellow powder. The pistil is divided into three or five stigmas. Likewise, the ovary is three to five celled. The number of stigmas is the same as the number of locks or divisions of the boll. As the flowers are only open one day, any fertilization that occurs must take place during that day. The flowers produce a sweet nectar that attracts insects. The nectaries are located at the base of the calyx on the inner side.

The Bolls. — The bolls, or the fruit of the cotton plant, resemble very much in shape an immature hickory nut, or a small hen egg. They vary in size from about one to two and one-half inches in length, and from one to two inches in width. It takes about 70 bolls of Cleveland cotton, short staple, 83 bolls of Lightning Express, long staple, and 130 bolls of the Sea Island, long staple, to make a pound of seed cotton. The boll is a further development of the ovary of the pistil. The immature bud, together with the peduncle, is spoken of by farmers as a "square." In some localities the young boll is incorrectly called a square. The boll is divided, from base to apex, into a number of valves, usually from three to five, depending upon the number of stigmas. These valves are hinged at their base, and as the boll begins to ripen a break in the line of cleav-

age occurs between the valves — commencing about halfway between the apex and the base — and gradually extends both ways until each valve is separate. They then bend back on their hinges until they are approximately at right angles to the peduncle, thus exposing three to five separate compartments filled with seed cotton. The contents of each compartment is called a lock. From 45 to 70 days usually elapse from the date of flowering until the boll opens, the length of time being determined by the variety, the temperature, the humidity, and the age of plant. The bolls reach their full size in about 24 days. The South Carolina Station found that bolls developing from squares which were formed early in the season reached maturity in from 48 to 55 days, while those which developed from squares formed later required from 55 to 70 days. After the seed cotton has been removed, the remainder of the boll is known as the bur.

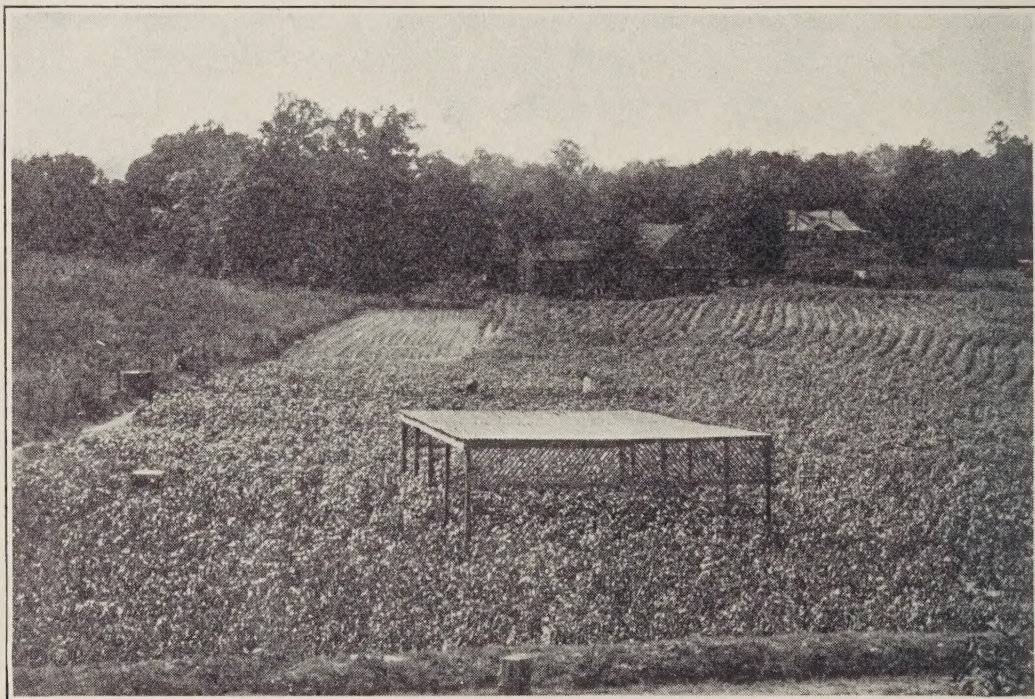


FIG. 4. — Latticed arbor used in connection with shading studies. (Courtesy, South Carolina Experiment Station.)

The Lint. — The cotton fiber, or lint, is a white, tubelike, unicellular structure of great strength arising from the epidermis of the seed coat. The strength is, no doubt, due to the fact that the fiber is composed of only one cell. When the cell is unripe it is perfectly straight, but as it begins to ripen it loses some of its water and becomes somewhat flattened. At the same time it begins to twist, giving to the fiber the appearance, when viewed under the microscope, of a bit. The number of twists in a ripe fiber will vary from three hundred to five hundred per

inch, depending upon the variety of cotton. The number of twists, or curls, per unit length determines to a great extent the spinning quality of the fiber. Those fibers which are unripe or half-ripe make a very poor piece of fabric, nor do they take dye as readily as fully matured fibers. As a general thing, the longest fibers are found at the top, or apex, of the seed, these being the first to develop, while the shortest are found near the base. Usually the longer the fiber the smaller the diameter. Short staple cotton has a mean diameter of about .0008 inches, and Sea Island .0006 inches. When the valves of the boll first open, the cotton appears as a moist, pearly white or in some cases brown, compact mass, but upon exposure to the air a great deal of water is lost from the fiber. The average cotton fiber is somewhat larger in the middle and ends abruptly where it is attached to the seed. The length of the cotton fiber will vary with the various varieties and species, but 1.2 inches is a general average for the cotton grown in the American Cotton Belt. If the separate fibers in a pound of cotton were placed end to end they would reach about 2200 miles. The fiber may be divided into three parts: (1) the outer membrane or cuticular envelope, together with a wax known as cotton wax; (2) pure cellulose; and (3) the hard dried-out protoplasmic contents of the cell in which may be included the endochromic coloring matter. The cotton wax decreases the absorbing power of cotton, and is removed in the manufacture of absorbent cotton.

The cotton fiber has a greater tensile strength than wool and less than silk. A wool fiber would have to be five miles, a cotton fiber fifteen miles, and a silk fiber twenty miles long before it would break of its own weight when suspended. The cotton fiber is less elastic, and absorbs less water than either wool or silk.

The Linters. — Also attached to seed of some varieties is a covering of very short fibers called linters. These fibers, or fuzz, make up about ten per cent of the total weight of the fiber, their diameter is about twice that of the lint. They vary in color from a white to a grayish-green, and remain very closely attached to the seed, even after the seed has been passed through the gin. There are, however, some species and varieties of cotton which produce clean, black seeds, without fuzz. This is particularly noticeable among the Sea Island cottons.

The Seed. — The seeds are attached to the boll at the inner angle of each compartment. As they mature they partially absorb their attachments and are pushed toward the center of the compartment by the developing lint. All the seeds of a compartment and the fiber to which they are attached constitute what is known as a lock of cotton. Cotton which has not been separated from the seed is known as seed cotton. In the process of separating, it takes, on a general average, 2 to 3 pounds

of seed cotton to produce one pound of lint. The seeds are about two-thirds the size of those of the cowpea, oblong in shape, and pointed toward one end. The seed may be divided into three parts: (1) the outer coating, or hull, called the testa; (2) the nucellus; and (3) the embryo, or the young dormant plant. The hull makes up about forty to fifty per cent of the seed. By cutting the seed in two the young cotyledons can readily be seen in a very compact and folded condition. Small black dots will also be noticed throughout the seed. These are called resin cavities, and after the germination of the seed appear scattered over the cotyledons of the young plant.

REFERENCES

1. Balls, W. Lawrence. The Development and Properties of Raw Cotton. A. and C. Black, Ltd., 1915.
2. Cook, O. F. Arrangements of parts in the cotton plant. U. S. D. A., Bur. of Plant Industry, Bul. 222, 1911.
3. Cook, O. F. Morphology of cotton branches. U. S. D. A., Bur. of Plant Industry, Cir. 109, 1913.
4. Galloway, B. T. The branching habit of Egyptian cotton. U. S. D. A., Bur. of Plant Industry, Bul. 249, 1912.

CHAPTER V

BOTANICAL CLASSIFICATION OF COTTON

Cotton belongs to the order Malvales, which is composed of three families: (1) Tiliaceae, or linden family; (2) Sterculiaceae, or chocolate family; (3) Malvaceae, or mallow family. Cotton is a member of the Malvaceae, or mallow family, as is also okra (*Hibiscus esculentus* L.), hollyhock (*Althaea rosea* Cav.), and a host of weeds and flowers.

The Malvaceae, or Mallow Family. — The Malvaceae comprises a group of herbs, shrubs, or trees. They have alternate, or spiral, palmately veined, and often lobed leaves. The flowers are regular. The stamens are numerous, uniting at their base and forming a tube or cone which fits around the pistil and connects with the base of the petals. There are five sepals and five petals. The seeds are kidney-shaped, or tapering at one end. When the seeds are cut in two, the young cotyledons can be easily seen in a very much doubled up or crumpled condition. They are innocent plants, mucilaginous, with very tough fibrous bark. The family is composed of about 40 to 50 genera and is confined mostly to the tropical zone. The cotton plant is the most important member of the family to man.

The Genus *Gossypium*. — Cotton belongs to the genus *Gossypium*. The members of this genus contain erect branching stems. They have petioled and palmately veined, lobed leaves. Their flowers are showy. The seeds are pointed, or tapered toward one end, and may or may not be covered with fuzz. The stigmas number from three to five, and always grow together. The number of stigmas determines the number of locks found in the mature boll. The name *Gossypium* was taken from the Arabic and given to cotton by Pliny.

Number of Species of Cotton. — Some botanists have divided the genus *Gossypium* into only three species, while others have claimed that as many as eighty-eight separate and distinct species exist. The great source of confusion among botanists seems to center around the question: "What is a species?" Linnæus divides the genus into three species: (1) *G. herbaceum*, (2) *G. barbadense*, (3) *G. arboreum*. The herbaceum includes the American Upland and Peruvian cotton; the barbadense, the Sea Island cotton; and the arboreum, the tree cotton of Asia. Parlatore names seven species as follows: (1) *G. barbadense*,

the long-stapled Barbadoes, Sea Island, Egyptian, and Peruvian varieties; (2) *G. herbaceum*, varieties of India, Siam, China, and Italy; (3) *G. hirsutum*, the American Upland varieties; (4) *G. arboreum*, a tree cotton growing fifteen to twenty feet in height, which is found in Ceylon, Arabia, South America, etc.; (5) *G. peruvianum*, the native varieties of Peru and Brazil; (6) *G. tahitium*, found chiefly in Tahiti and

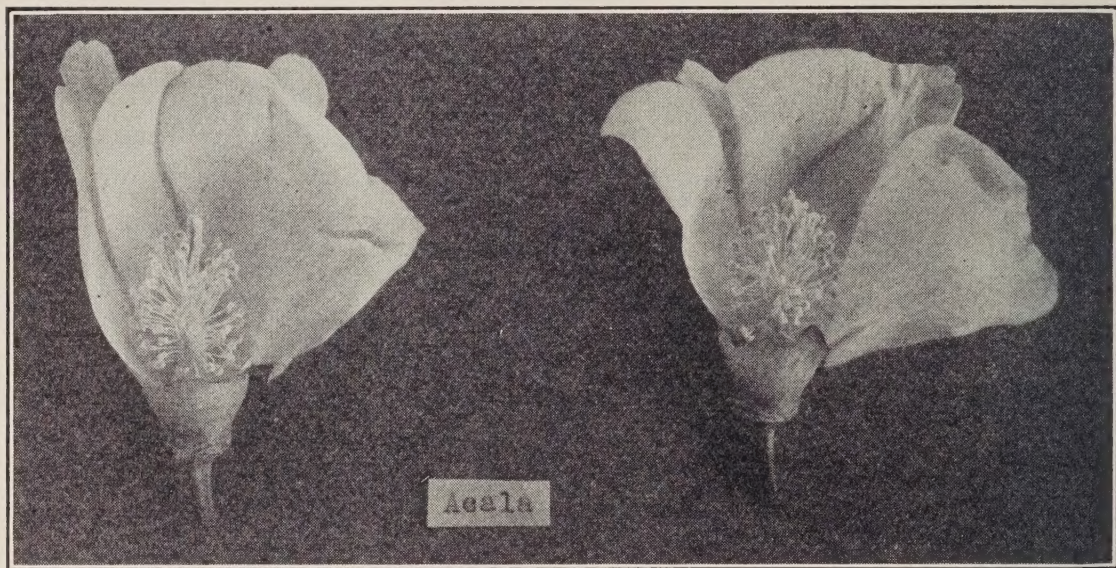


FIG. 5. — Vertical section of upland cotton, Acala variety, showing the position of the stigmas and stamens. (Courtesy, U. S. Dept. of Agriculture.)

the Society Islands; and (7) *G. sandwichense*, found in the Sandwich and adjacent islands. De Candolle recognizes thirteen species, and Todaro fifty species. The United States Bureau of Plant Industry recognizes the following species: (1) *G. hirsutum* L., or American Upland; (2) *G. herbaceum* L., or Indian cotton; (3) *G. barbadense* L., or Sea Island; and (4) *G. peruvianum* Cav., or Peruvian cotton. This classification is the one commonly recognized.

Since cotton is grown in both America and Asia, the name American and Asiatic cotton is often heard in the world markets. The American includes the American Upland, Sea Island, and Peruvian cottons. The Asiatic includes the Indian and Bengal cotton.

American Upland Cotton (*Gossypium hirsutum* L.). — The American Upland cotton is grown to a greater extent in America, and therefore in the world, than any other species. In fact, over 95 per cent of the cotton grown in this country is the Upland. This species has been derived from a native cotton of the Mexican tropics, which was cultivated by the Moqui Indians before the white man came to America, and from cottons brought from other parts of the world and introduced into the Cotton Belt at the same time as the Mexican species. The

seeds of the varieties of this species are characterized by being covered with a whitish, brownish, or greenish fuzz. The species may be divided into two main groups, the short fiber varieties, and the long fiber varieties. The fiber of the short fiber group ranges in length from three-fourths to one and one-eighth inches. The fiber of the long fiber group ranges from one and three-sixteenths to one and five-eighths inches in

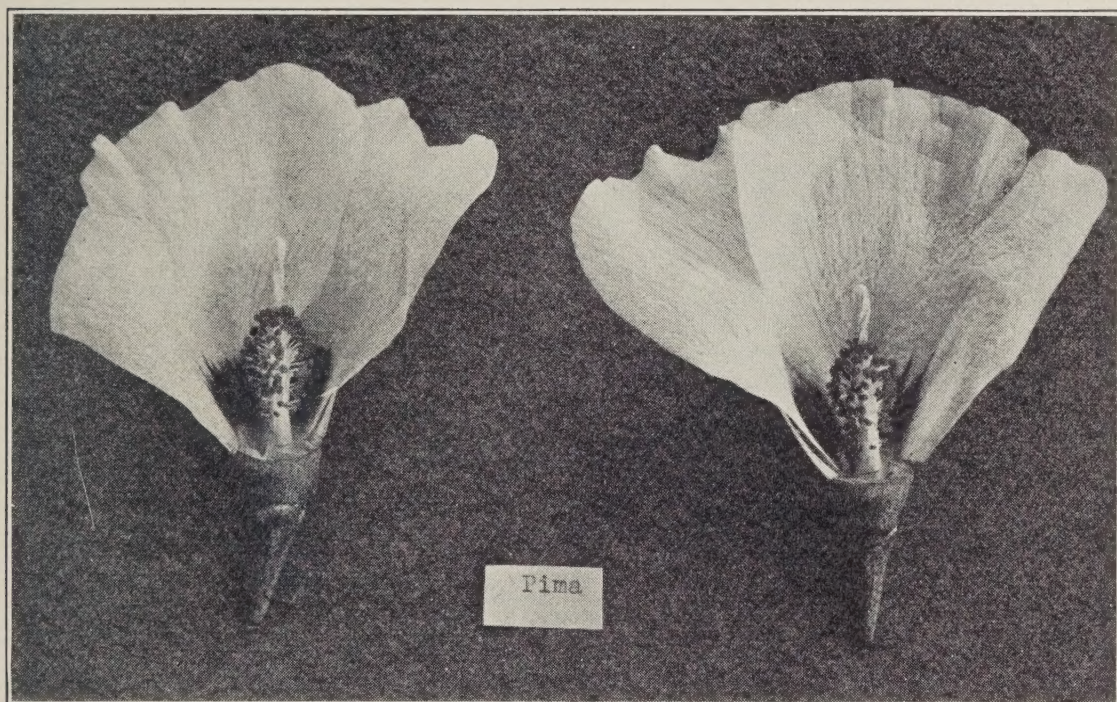


FIG. 6. — Vertical section of Egyptian cotton, Pima variety, showing the position of the stigmas and stamens. (Courtesy, U. S. Dept. of Agriculture.)

length. This cotton has been produced chiefly in the Delta region of western Mississippi, but in recent years it has also been grown in eastern Arkansas and northeastern Texas, and a small quantity in the Carolinas. In the last few years the growing of long staple Upland cotton has been established on irrigated lands in the Imperial Valley of California, the industry in that locality being based on the Durango variety. While a few varieties of long staple Upland cotton sometimes produce fiber having a staple of one and one-half inches or longer, the staple of the bulk of the crop is less than one and three-eighths inches in length.

A higher price is paid per pound for the long staple, but the average yield per acre of the long staple varieties has not until recently been as great as the yield of the short staple varieties.

This species has during the last half century been taken to Russian Turkestan, Persia, Bengal, India, Porto Rico, and German and British West Africa.

Sea Island Cotton (*Gossypium barbadense* L.) — Sea Island cotton does not do well in the upper part of the Cotton Belt. In fact, it will grow only in a restricted area which takes in a part of South Carolina, Georgia, and Florida. When Columbus discovered America he found the natives growing this species in the West Indies. It is also found growing in St. Vincent, Barbadoes, St. Kitts, and Peru. The plants of the

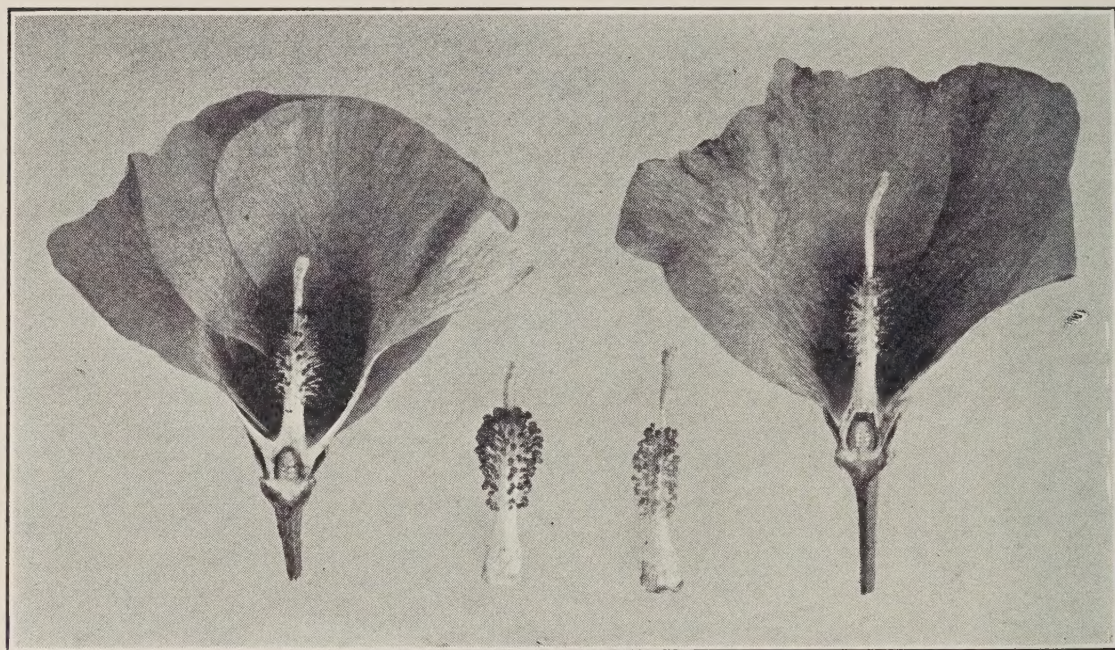


FIG. 7. — Vertical section of cotton flowers. On the left Pima variety of Egyptian cotton. On the right Sea Island cotton, showing characters of the reproductive organs similar to those of Pima, except that the stigmas are longer and less densely screened at the base by the upper stamens. (Courtesy, U. S. Dept. of Agriculture.)

barbadense range from three to eight feet in height. The branches are more flexible than are those of the Upland. The leaves have from three to five lobes, and are deeply cut. The bolls are more pointed than are the bolls of the Upland. The seeds are black and smooth. The flowers are yellow, with a reddish-purple spot at the base of each petal. The bolls contain from three to five locks. The lint is also longer and more valuable than is the lint of the Upland, the fiber ranging from 1.4 to 2.5 inches in length. It is silky, pure white, and easily removed from the seed. The prices are much higher for Sea Island than for Upland, but the cotton is harder to pick and gin, and the yield is less than is the case with Upland.

Indian Cotton (*Gossypium herbaceum* L.). — This cotton is a native of the Asiatic tropics, and is cultivated principally in India, China, Asia Minor, Persia, Japan, and Indo-China. The best grade of Indian

cotton is grown in southern Madras. When compared to the American Upland cotton the Indian cotton plants are found to be more slender, the stems less woody, the lobes of leaves more rounded, and bolls more spherical. The flowers vary from a bright yellow to a purple. The lint also varies in color, shading from white, through a yellow to a golden brown. The fiber is coarse, and shorter than is the American Upland, being, on an average, from one-half to one inch in length. Most of the lint is used for domestic purposes. Some monographers divide the Asiatic cotton into three species, *Gossypium herbaceum* L. or Levant cotton, *Gossypium obtusifolium* Roxb. or Ceylon cotton, and *Gossypium indicum* Lam. or Chinese cotton.

Egyptian Cotton. — The Egyptian cotton may be said to be a modified form of Sea Island. Having been cultivated in Egypt now for years

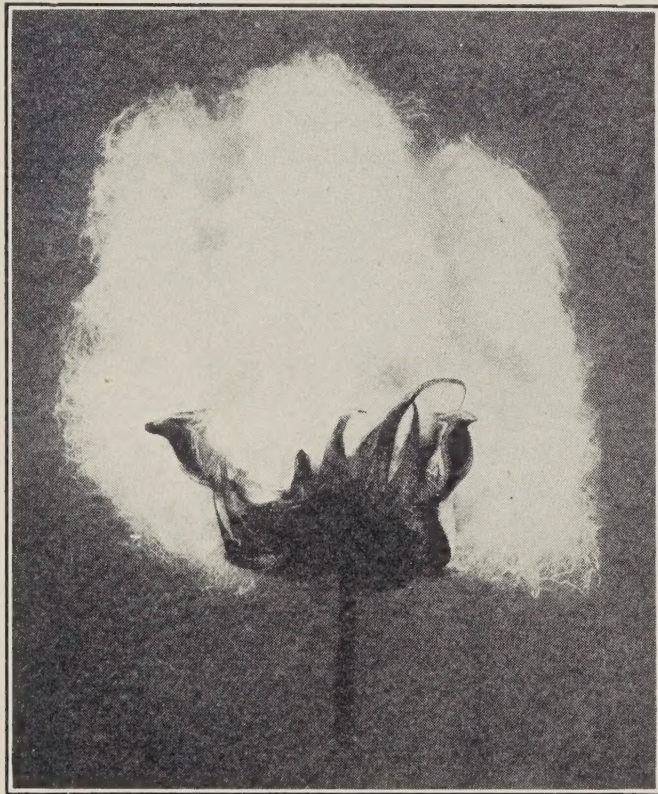


FIG. 8. — Open boll of long staple cotton. (Courtesy, U. S. Dept. of Agriculture.)

under conditions that are far different from its native home, it has become changed somewhat, through the action of natural selection. It has also become mixed with old world cottons. The staple ranges in length from one and three-eighths to one and three-fourths inches. The average yield per acre of seed cotton in Egypt is about twice that of the United States, and four times that of India.

Peruvian Cotton (*Gossypium Peruvianum* Cav.). — Peruvian cotton is grown principally in Peru and Brazil. It has been carried to the Phillipines and other islands of the Pacific. It resembles very much Sea Island. The color of its lint also varies from a white, through a yellow, to a brownish. The length of the fiber is about halfway between the American Upland and Sea Island. The seeds of each lock are grouped together in a cluster. They are usually covered with a grayish or greenish fuzz, although in some varieties the seeds are naked. The varieties not only vary widely as to color of fiber, but also as to texture of fiber. The fiber of some varieties, when made up into cloth, resembles very much wool fabric.

Bengal Cotton (*Gossypium arboreum* L.). — This is the tree cotton, which is grown only in India. Its flowers are purple with a dark center. The lint is short and of a very inferior quality.

REFERENCES

1. Memoirs of the Department of Agriculture in India, Vol. VI, No. 4, Part 1.
2. Todd, John A. The World's Cotton Crop. A. and C. Black, Ltd., 1923.
3. Watt, Sir George. The Wild and Cultivated Cotton Plants of the World. Longmans Green & Co., 1907.

CHAPTER VI

PHYSIOLOGY AND CHEMISTRY OF THE COTTON PLANT

A brief review of certain phases of the physiology and chemistry of plants in general, and in some instances of cotton in particular, should give us a better working knowledge of those essential life processes that go on within the plant, and help us to understand, to a better degree, all the phases of cotton production.

The Plant Cell. — The unit of plant structure is called the cell. The roots, the stems, the leaves, in fact, every part of the plant is made up of groups of these cells. Each of these cells has been, or is, a living individual capable of performing all the functions characteristic of living matter, such as the absorption and digestion of food, growth, reproduction, etc. With the one-celled plants, such as bacteria, each individual cell performs all the functions necessary for its existence and propagation on the earth. However, with the higher forms of plants each cell does not perform all the functions necessary for its existence, but each cell is assigned some particular duty or definite function to perform, being dependent largely upon other cells of the organism to perform the other necessary life functions in which it does not specialize. Thus, we have in the cotton plant a group, or society of cells, each cell being more or less dependent upon every other cell of the plant to perform the duties assigned to it. The cells of the stalk and leaves, for instance, are dependent upon the cells in the roots to supply them with water and nutrients taken from the soil, while the cells of the developing cotton seed are dependent upon the cells of the leaves to manufacture carbohydrate which is used by the cells of the seed in the production of fiber.

Size and Shape of Plant Cells. — The great majority of plant cells are microscopic in size. They have no universal shape, although cells of the leaves may have some definite shape characteristic that will distinguish them from the cells of the roots. Their shape is usually correlated to some extent with the kind of work that the cell has to perform. Thus, the cells of the conductive tissues of the stem are oblong, some of them being drawn out to great lengths in a tubelike structure. The function of these cells is to act as passageways for the food and water which may pass to and from the roots and leaves.

Divisions of the Plant Cell. — The plant cell may be roughly divided into two parts: first, the cell wall, or the framework, within which the living part of the cell resides; second, the living part of the cell, which is called protoplasm. The cells of the plant may be living or dead. If they are living the cell walls are filled with the protoplasm; if they are dead the protoplasm usually has dried up. Only a small proportion of the living plant, as we think of it, is composed of living cells. Many of the cells of the outer bark and of the conductive tissue, particularly of the woody plants, are dead cells. This does not mean, however, that dead cells are of no value to the plant for, as a matter of fact, they serve many purposes of an essential nature.

The Cell Walls. — The cell walls, both of the living and dead cells, compose the framework, or skeleton, of the plant. This wall is built by the protoplasm, and is made up largely of cellulose, a chemical compound composed of the elements carbon, hydrogen, and oxygen, which is similar to starch, and of the same composition as the cotton fiber. In fact, the cotton fiber itself when mature is a single dead cell, the protoplasm which filled the cavity during the immature stages of the fiber having died and dried up as the fiber matured.

The Protoplasm. — The protoplasm is a jelly-like, translucent substance which is made up principally of the elements carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur. Compounds of this type may usually be classified as proteins. This protoplasm has the power to grow in size and to reproduce itself. The growing cell first increases in size until it becomes of a certain bulk, then it splits in two, forming two cells, each of which can perform all the functions of the other. Thus, when we speak of growth of a plant, we refer to two processes: (1) the enlarging of the individual cells; and (2) the increasing of the number of cells.

Essential Elements Required by Every Plant. — All living plant cells, and therefore, all plants, require ten elements of the medium in which they grow. These elements are carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, potassium, calcium, iron, and magnesium. All these elements are found in the plant upon analysis. Other elements may also sometimes be found, such as silicon, manganese, sodium, chlorine, etc., but it has been supposed that plants only tolerate these substances, and though the plants may even put them to some use these elements are not essential in order that growth may proceed. The carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur, as has already been seen, are part of the living protoplasm. Potassium, calcium, iron, and magnesium may not constitute a part of the living substance, but are thought to be used only as tools, as it were, by the

plant in its life functions. Although the functions that each of these perform are not definitely known, it is known that one cannot perform entirely the functions executed by the other. However, it is thought that some elements may perform part of the functions of the other, and also that even some of the non-essential elements that are sometimes found in the plant may perform some of the functions of these four essential ones. The percentage of amounts of the elements absorbed by the cotton plant depends upon many factors, among which may be mentioned the variety, the soil and climatic conditions, and the available supply of these elements.

The Source of the Essential Elements. — The carbon and part of the oxygen of the cotton plant come from the air, the hydrogen and part of the oxygen from water, the nitrogen, phosphorus, sulfur, calcium, iron, potassium, and magnesium from the soil. The elements carbon, hydrogen, and oxygen make up the greater part of the plant, so that most of the plant comes directly or indirectly from the air and water, and the least amount from the soil.

Amount of Water found in the Cotton Plant. — About 90 per cent of the young cotton plant is made up of water and about 10 per cent of dry matter. In the mature cotton plant the percentage of water has been reduced to less than one-half of the percentage found in the young plant, and the percentage of dry matter has increased to from 35 to 50 per cent. The average transpiration ratio for cotton, according to Barre, is about 300.

Absorption of Plant Nutrients from the Soil. — As has been said, some of the plant nutrient elements come from the air, some from water, and some from the soil. When these elements are available, and when conditions of growth are normal, the plant has the power to absorb them from the surrounding medium at such a time and in such quantities as the forces controlling growth will allow. These are combined, or manufactured into food, principally in the leaf, as we shall see later. The Georgia Station has shown that approximately 33 per cent of the plant nutrients taken up by the cotton plant is absorbed within the first thirty days, 33 per cent within the second thirty days, and 85 to 90 per cent by the end of the first ninety days. Of the total dry matter produced 50 per cent is produced during the first ninety days.

Composition of the Cotton Plant. — In the following table is given the percentage composition of the cotton plant, at various stages of growth, as compared with that of the mature plant, as determined by the Georgia Experiment Station after four years of investigation.

THE COMPOSITION OF THE COTTON PLANT AT VARIOUS STAGES OF GROWTH, GIVEN ON A PERCENTAGE BASIS

Dry	First square	First bloom	First open boll	Mature plant
Dry matter.....	12.2	28.8	48.5	100
Total mineral (ash).....	28.6	63.1	82.0	100
Nitrogen.....	34.0	66.0	84.2	100
Phosphorus.....	36.6	76.8	95.3	100
Sulphur.....	43.1	75.0	84.7	100
Potassium.....	35.5	62.0	76.0	100
Calcium.....	32.8	74.0	84.0	100
Magnesium.....	38.0	69.3	89.4	100

Photosynthesis. — Under suitable conditions green cells of the leaf have the power to synthesize carbohydrates, and thus store up energy that is derived from the sun, for their metabolic processes. Because this synthesis can only take place in the presence of light, it is called photosynthesis. The products manufactured are composed of carbon, hydrogen, and oxygen, such as sugar, starch, and cellulose. The carbon and oxygen used in the manufacture are taken from the air as carbon dioxide, a compound composed of one part of carbon and two parts of oxygen, which makes up about .04 per cent of the atmosphere. This carbon dioxide enters the leaf through numerous small openings called stomata. The cotton leaf contains about 200,000 stomata per square inch on the lower side, and about 70,000 on the upper side. The carbon dioxide passes in through the stomata into the small passageways between the cells. However, in this condition it is still of no value, but must first go into solution before it can enter the manufacturing cell. This is readily accomplished, for the cells of the leaves are continuously bathed in water that is passing through the plant from the soil, and the carbon dioxide is readily absorbed by this water. The solution containing carbon dioxide passes through the cell walls of the leaf just as the soil solutions pass through the cell walls of the root hairs.

Translocation of Food in the Plant. — As the carbohydrates are manufactured in the leaf they are converted into the soluble members of the group, such as the sugars, and are taken away, either directly to the cell in need of them, or to some place where they are stored for future use. However, the process of manufacture sometimes goes on at a more rapid rate than does the process of removal, so that at the end of the day, when photosynthesis stops, the leaves are often found

chock-full of starch. Nevertheless, the process of removing can proceed at night as well as in the day, so that by the following morning all the manufactured foods have been removed.

Processes Involved in Fertilization. — The flowers of cotton are large and are easily cross-pollinated by insects. Self-fertilization may easily take place in the American Upland species, because of the fact that the style is short and the stigma is below many of the anthers. With the Egyptian species the style is long and the stigma well above the anthers, so that self-fertilization is not so likely to take place. The pollen grains of cotton are nearly spherical in shape. On the style of the flower are a number of hairs which secrete a fluid. This fluid is sticky and holds any pollen grains that may come in contact with it. It also has some physiological effect upon the pollen, for the grains which come in contact with it are caused to germinate. By germination we mean that the pollen tube elongates and passes down the style toward the ovary. When the pollen tube reaches the ovary it bursts, and from the torn end escape two male gametes, one of which passes to, and fuses with, the female or egg-cell, forming a zygote, and thus beginning a new life history. The other male fuses with the two polar nuclei of the egg-cell, and the triple nucleus thus formed serves later to provide the endosperm of the seed. This type of fertilization is known as double fertilization. Germination takes place in cotton very soon after the pollen cell comes in contact with the stigma, and fertilization has necessarily been completed within 24 to 36 hours after the opening of the flower. From forty to sixty days after fertilization the boll is mature.

REFERENCES

1. Balls, W. Lawrence. The Development and Properties of Raw Cotton. A. and C. Black, Ltd., 1915.
2. Ewing, F. C. A study of certain environmental factors and varietal differences involving the fruiting of cotton. Mississippi Exp. Sta. Tech. Bul., 8, 1918.
3. Fraps, G. S. The chemical composition of the cotton plant. Texas Agr. Exp. Sta., Bul. 247, 1919.
4. Harris, J. Arthur, *et al.* The leaf-tissue fluids of Egyptian cottons. Jour. Agr. Research, Vol. XXXI, No. 11, 1925.
5. Matthews, J. M. The Textile Fibers. John Wiley & Sons, Inc., 1924.
6. Stanford, Ernest E., and Viehoveer, Arno. Chemistry and histology of the glands of the cotton plant, with notes on the occurrence of similar glands in related plants. Jour. Agr. Research, Vol. 13, No. 8, 1918.
7. The Cotton Plant. U. S. D. A., Office of Experiment Station, Bul. 33, 1896.
8. White, H. C. The feeding of cotton. Georgia Exp. Sta., Bul. 108, 1914.
9. Viehoveer, Arno; Chernoff, Lewis H.; and Johns, Carl O. Chemistry of cotton plant, with special reference to Upland cotton. Jour. Agr. Research, Vol. 13, No. 7, 1918.

CHAPTER VII

CLASSIFICATION OF AMERICAN UPLAND COTTON VARIETIES

The cotton plant reacts quite readily to any change in environment. It also crosses very easily, not only artificially but naturally. It is for these reasons that there exist in the Cotton Belt today between one and two hundred varieties of the Upland cotton, and many more so-called varieties that differ among themselves only in name.

What is a Variety? — Generally speaking, any group of plants found in a species differing in one or more characteristics from the rest of the species may be classified as a variety.



FIG. 9. — Method of labeling variety tests at the Georgia Experiment Station. (Courtesy, Georgia Experiment Station.)

Groups of Cotton Varieties. — The following classification of the American Upland species of cotton has been suggested by Prof. J. F. Duggar, of the Alabama Station. It is by far the most satisfactory system that has yet been proposed.



FIG. 10. — Plant of Dixie cotton. (Courtesy, U. S. Dept. of Agriculture.)

1. Cluster type.
2. Semi-cluster type.
3. Rio Grande, or Peterkin type.
4. Early varieties of the King type.
5. Big-boll type.
6. Long-limbed type.
7. Intermediate varieties.
8. Long-staple upland varieties.

These groups, however, are not clear-cut units of the species, for the characteristics of some groups may overlap.

Since Professor Duggar first suggested the above classification the cluster and semi-cluster groups have merged into other groups and their characteristics have been obscured by other characteristics of more importance. The Rio Grande and long-limbed groups have almost completely disappeared so that we have now only four predominant types.

The Cluster Group. — This group is characterized by plants containing short, slender branches. The leaves on the main stem are large, while those on the fruiting limbs are small. The bolls are seldom large, and are grouped together in clusters, two to three bolls sometimes being produced from the same node. The seeds are small and are covered with a thick fuzz. One of the greatest objections to the whole group is the fact that the squares tend to drop off during bad weather.

Examples: Dickson, Jackson

The Semi-cluster Group. — This group is thought by some to have originated as a hybrid of the cluster group and some other group. It resembles very much the cluster group, although the bolls are not grouped into clusters to the same extent as is found in the cluster group. The size of the bolls and the seeds is variable. The middle and upper limbs are longer than in the cluster group.

Examples: Poulnot, Hawkins

The Rio Grande or Peterkin Group. — The plants of this type are characterized by slender, long-jointed branches. The bolls are small but contain a high percentage of lint, usually from 37 to 40 per cent. The seeds are small, black, and naked, except for a tuft of fuzz at the beak. It is not an early maturing type so has been little grown since the boll weevil entered the country.

Examples: Layton, Peterkin

The Early or King-like Group. — These are low plants with numerous crooked branches of medium length. This type was developed in the northern part of the Cotton Belt where the seasons are short. It is the earliest group that we have. The leaves are more deeply cut than in the big-boll varieties, and the bolls are smaller. The lint is short, but it is very easily picked. The seeds are covered with a greenish or brownish fuzz.

Examples: King's Improved, Simpkins

The Big-Boll Group. — The big-boll group is characterized by large, short-jointed plants, with large leaves. The bolls are large and from

medium to late maturing. It takes less than 70 of the larger bolls to make a pound, while with the smaller boll varieties 90 to 100 may be necessary. This group may be divided into three divisions:

- (a) Storm-proof, big-boll varieties, such as the Triumph and Rowden.
- (b) The big-boll varieties of the shape which characterizes the semi-cluster type, such as the Truitt.
- (c) The big-boll varieties having neither storm resistance nor semi-cluster shape of plant, such as the Cleveland and Russell.



FIG. 11. — Plant of Foster cotton. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

The Long-limbed Group. — These are large plants with long limbs and long internodes. They are late in maturing. The group is rapidly disappearing.

Examples: Petit Gulf, Peeler, Red Leaf

Intermediate Varieties. — These varieties, as the name implies, are intermediate in characteristics between any of the above groups.



FIG. 12. — Plant of Cleveland cotton. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

Examples: Eureka, Toole, Excelsior

The Long-staple Upland Group. — These are tall plants, slender, and having a semi-cluster arrangement of the bolls. The bolls are of medium size, slender, and tapering to a point. The lint is long, ranging from $1\frac{3}{16}$ to $1\frac{3}{4}$ inches in length. The group as a whole is more or less subject to anthracnose, and formerly was nearly always late in maturing, but rather recently many varieties of medium maturity have been developed.

Examples: Webber, Delfos, Meade

Classification of Varieties. — Before the entrance of the cotton boll weevil into the eastern states of the Cotton Belt the Alabama Station

made the following classification of a large number of varieties which were secured by them to be used in a classification test. Under boll weevil conditions many of these varieties have become extinct or nearly so. As yet, no investigator has attempted to classify the varieties now being grown.

Cluster varieties	Dickson Jackson, Welborn
Semi-cluster varieties	Barnett, Berryhill, Blue Ribbon, Cummings, Defiance, Dongola, Featherstone, Garrard, Haralson, Hardin, Hawkins, Herndon, Hilliard, Lealand, McCall, Minor, Montclare, Norris, Peerless, Pullnot, Rogers, Sterling, Tyler, Woodfin
Rio Grande varieties or Peterkin group	Borden, Dearing, Eureka, Favorite, Layton, Park's Own, Speight
Short Limb varieties of the King Group	Dozier, Grier, Goldust, Hodge, King, Lowry, Mascot, Missionary
Big-boll varieties	Alexander Allen, Anderson, Bancroft, Banks, Berry, Bohemian, Cheise, Christopher, Cleveland, Cliett, Coppedge, Culpepper, Diamond, Double Header, Dongola, Drake, Duncan, Ellis, Grayson, Gunn, Haralson, Hunnicutt, Hutchinson, Jones, Langford, Lee, Maddox, Montclare, Mortgage Lifter, Ozier Big Boll, Reliable, Rogers, Rowden, Ruralist, Russell, Scogin, Sewell, Schley, Smith Improved, Smith Standard, Southern Wonder, Spearman, Strickland, Tatum, Texas Bur, Texas Storm Proof, Thrash, Todd, Triumph, Truitt, Webber-Russell, Whitten, Wyche
Long Limb varieties	Hagaman, Louisiana, Peeler, Petit Gulf
Intermediate varieties	Breeden, Boyd, Edgeworth, Eureka, Excelsior, Gold Standard, Hunnicutt, Lewis, Meredith, Roby, Rasser, Sprueill, Tucker, Webber-Russell
Long Staple varieties	Allen Hybrid, Allen Improved, Cook (W. A.), Doughty, Griffin, Mathews, Moon

Percentage of Lint. — The percentage of lint in the short staple Upland cotton may run as high as 35 to 40 and as low as 29 to 32 per cent. Sea Island cotton formerly produced 20 per cent lint, but in some varieties it now produces 30 per cent. Long staple Upland usually runs less than 30 per cent lint but may vary between 27 and 32 per cent.



FIG. 13. — Plant of Hartsville cotton. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

Shedding of Bolls. — Forty to 60 per cent of the bolls of most varieties are shed. In 1923 the South Carolina Agricultural Experiment Station found in its variety test, which consisted of twenty varieties of cotton, that the per cent of bolls shed varied from 37 in the case of Lightning Express to 60 in the case of the Trice variety. This station also found, as a result of experiments carried on for three years, that



FIG. 14. — Plant of Webber 49 cotton. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

the percentage of flowers producing bolls during the first week of blooming ran about 88, and that the weekly percentage decreased as the flowering period progressed, so that at the end of the eighth week only 8 per cent of the flowers produced mature bolls. Shedding may take place before the corolla of the flower falls, or it may occur as late as full maturity of the boll. Most of the shedding takes place from two to

ten days after the opening of the flower. Undesirable conditions, such as drought and water-logged soils, increase the percentage of shedding. Deep cultivation late in the season, and weevil damage,

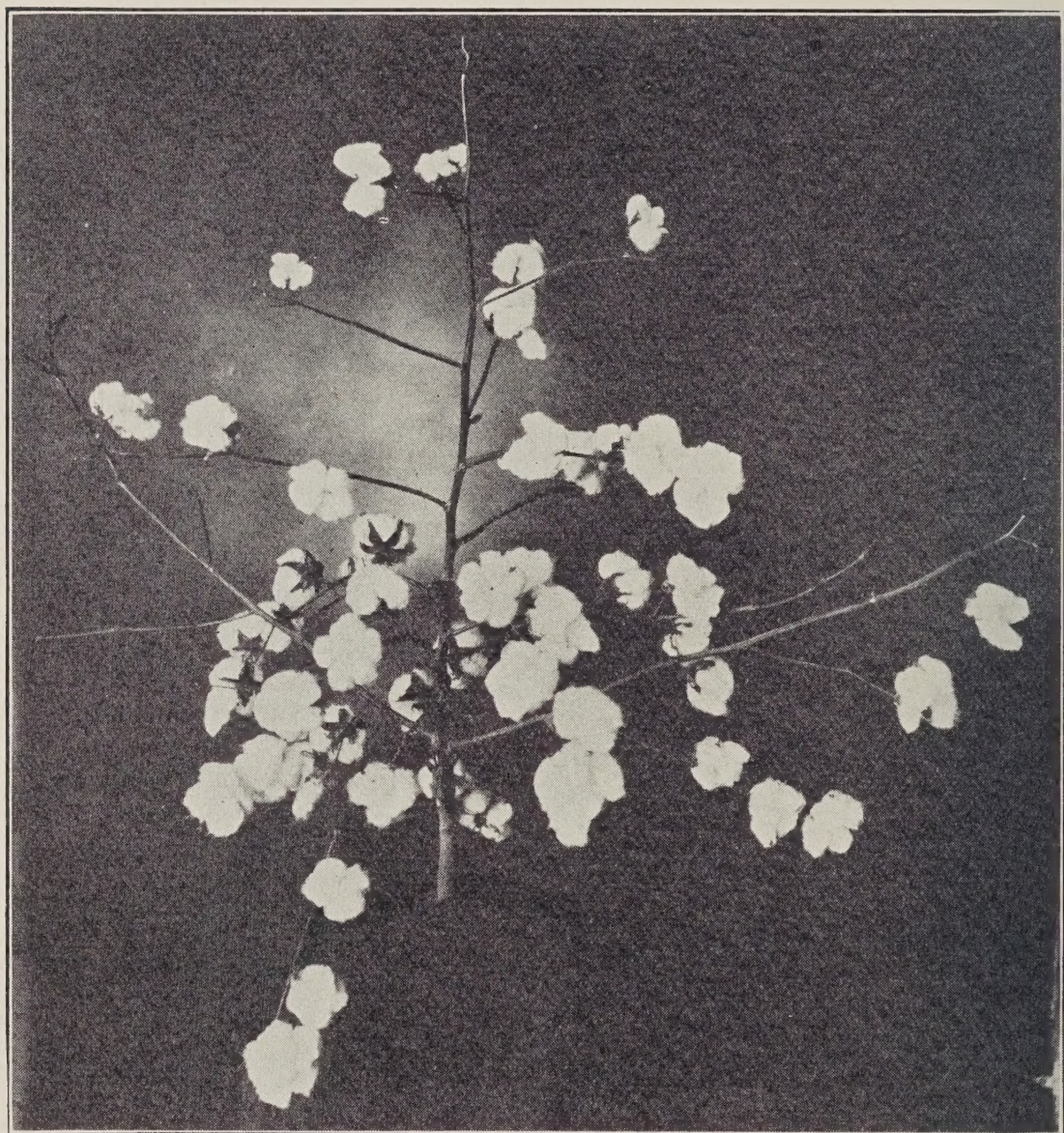


FIG. 15. — Plant of Lightning Express cotton. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

also increase the normal percentage of shedding. Early flowering varieties usually have a rapid rate of flowering, but the tendency of varieties which bloom so early and in such profusion is to slow up early and cancel the benefit gained by excessive shedding. This is particularly noticeable with the Trice and Simpkins varieties. Since the entrance of the cotton boll weevil, not only earliness must be bred for but also low rate of shedding and rapid flower production.

Leading Varieties West and East of the Mississippi River. — Mebane or Triumph, followed by Lone Star, is the leading variety west of the Mississippi River. Wannamaker-Cleveland is the leading variety east of the Mississippi River.

Origin of a Few Representative Varieties. — The origin of all of our varieties of cotton is somewhat similar. They were usually secured from selections, made by some one man or group of men, out of some other variety, or perhaps just out of common cotton. In some instances, however, the varieties have originated as a result of crosses made between two varieties. Below is given an example of the origin of one variety from each group recognized by Duggar.

Cluster Group

Dillon. — The Dillon variety of cotton was developed by selection from the Jackson Limbless by W. A. Norton, of the United States Department of Agriculture.

Semi-cluster Group

Blue Ribbon. — This variety was originated as a cross between the Allen Long Staple and the Dickson variety. The cross was made by Col. J. S. Newman, of the South Carolina Agricultural Experiment Station.

Big-boll Group

Cleveland Big-boll. — This cotton was developed through a process of selection, extending over twenty-five years, which was carried on by J. R. Cleveland, of Decatur, Mississippi.

The Early Group

King. — A very early variety of cotton that was bred from Sugar-loaf cotton by T. J. King, of Louisburg, North Carolina.

The Rio Grande Group

Toole. — This variety of cotton originated from the Peterkin variety and was developed by W. W. Toole, of Augusta, Georgia.

Long-limbed Group

Hagaman. — This variety is thought to have originated from a variety known as Dean, near Jackson, Louisiana.

Intermediate Varieties

Russell. — Originated by J. L. Russell, of Alexander City, Alabama, from a chance plant.



FIG. 16. — Plant of Super-Seven cotton. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

Long Staple Upland Varieties

Hartsville. — This variety was selected out of a variety of cotton known as Jones' Big Boll by Mr. David R. Coker, of Hartsville, S. C.

Variety Tests. — No one variety is adapted to all conditions of the Cotton Belt. The variations in the length of the growing season, the soil, the rainfall, etc., explain why some varieties which are of little value in some localities stand the highest in others. Storm-proof varieties are wanted in Oklahoma and Texas, while early varieties are desirable in Tennessee and North Carolina.

The state experiment stations of the Cotton Belt, realizing the necessity of having accurate data in regard to the relative yielding qualities and resistance to wilt, storms, etc., have for a number of years con-

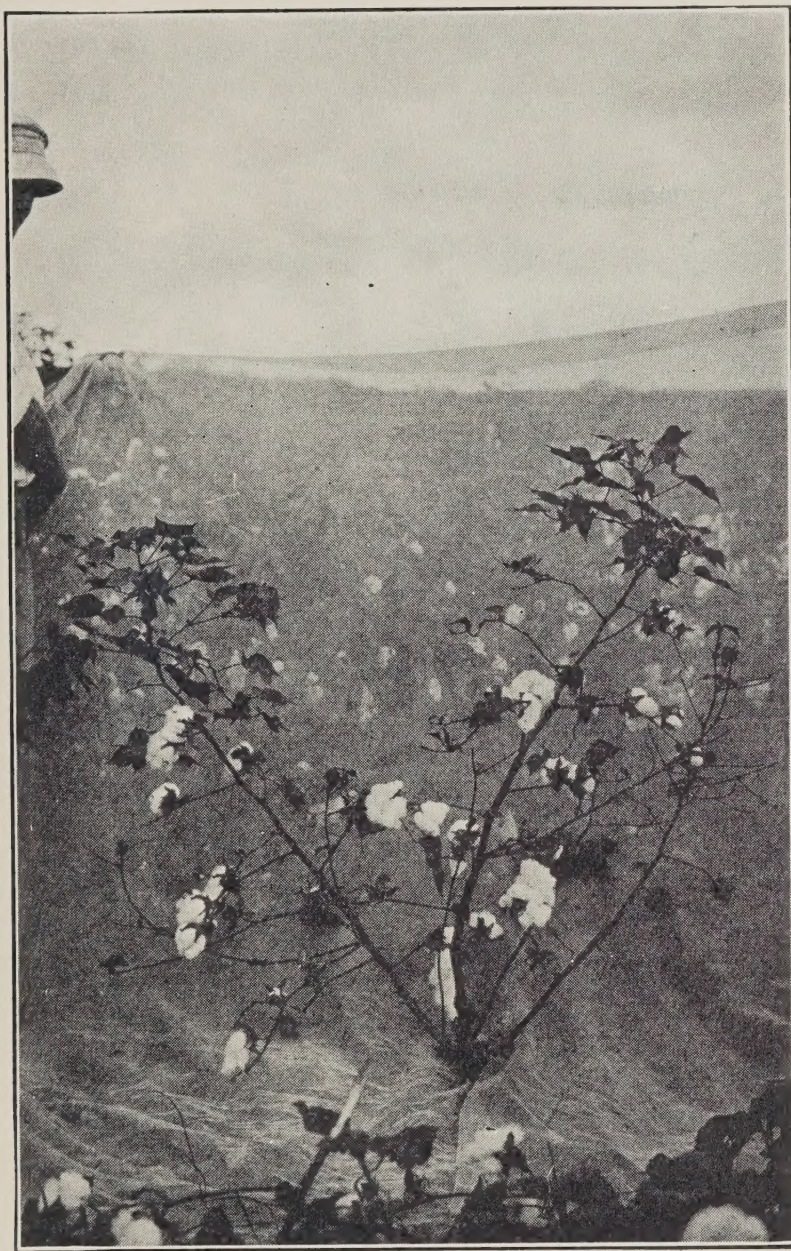


FIG. 17. — Plant of King cotton. (Courtesy, U. S. Dept. of Agriculture.)

ducted variety tests with cotton on their several farms. Below is a list of representative high ranking varieties in each state, as given by the agronomist of each state in September, 1925. However, as the years go by, new varieties assume places of importance, so that each year farmers should find out what varieties their state experiment stations are recommending.

48 CLASSIFICATION OF AMERICAN UPLAND COTTON VARIETIES

Alabama	Short staple	Cook (several strains) Cleveland (several strains)
	Wilt resistant	Toole Cook 307-6
Arkansas	Short staple	Trice Triumph (several strains) Cleveland (several strains) Lone Star Rowden
	Long staple	Acala Delfos Express Webber (several strains)
Georgia	Short staple	Cleveland (several strains) Cook 588 College No. 1
	Long staple	Acala Lightning Express Salsbury
Louisiana	Short staple	Cleveland (various strains) Lone Star 65
	Long staple	Delfos 6102 Deltatype Webber Lightning Express
	Wilt resistant	Alex Wilt Resistant Cook 307 Dixie-Triumph
Mississippi	Short staple	Cook (several strains) Cleveland (several strains) Trice
	Long staple	Delfos Express 432 Lightning Express Salsbury
North Carolina	Short Staple	Cleveland (several strains) Mexican
	Long staple	Delfos
	Wilt resistant	Dixie-Triumph
Oklahoma	Short Staple	Lone Star Mebane or Triumph Rowden
	Long staple	Acala
South Carolina	Short staple	Cleveland (several strains)
	Long staple	Deltatype Webber Express
	Wilt resistant	Dixie-Triumph

Tennessee	Short staple	Cleveland (several strains)
		Mexican
		Trice
	Long staple	Express
Texas	Short staple	Cook
		Burnett
		Lone Star
		Mebane or Triumph
		Rowden
	Long staple	Acala



FIG. 18. — Plant of Triumph cotton. (Courtesy, U. S. Dept. of Agriculture.)

Some Characteristics of Our Most Common Varieties. — In the Appendix will be found a table taken from Arkansas Agricultural Experiment Station Bulletin 157, summing up some of the major seed cotton characteristics of 442 varieties as given in all previous published data concerning these varieties. It should be remembered, however, that some of these varietal names may refer to the same variety.

The Characteristics of Some Commonly Grown Varieties

Cleveland. — The Cleveland variety belongs to the big boll type. The limbs are short to medium in length, and become well supplied with bolls. The bolls are large and blunt. When the bolls are open the seed cotton is easily separated from the bur. The seeds are of medium size and fuzzy. The variety may be classified as early to medium in maturing.

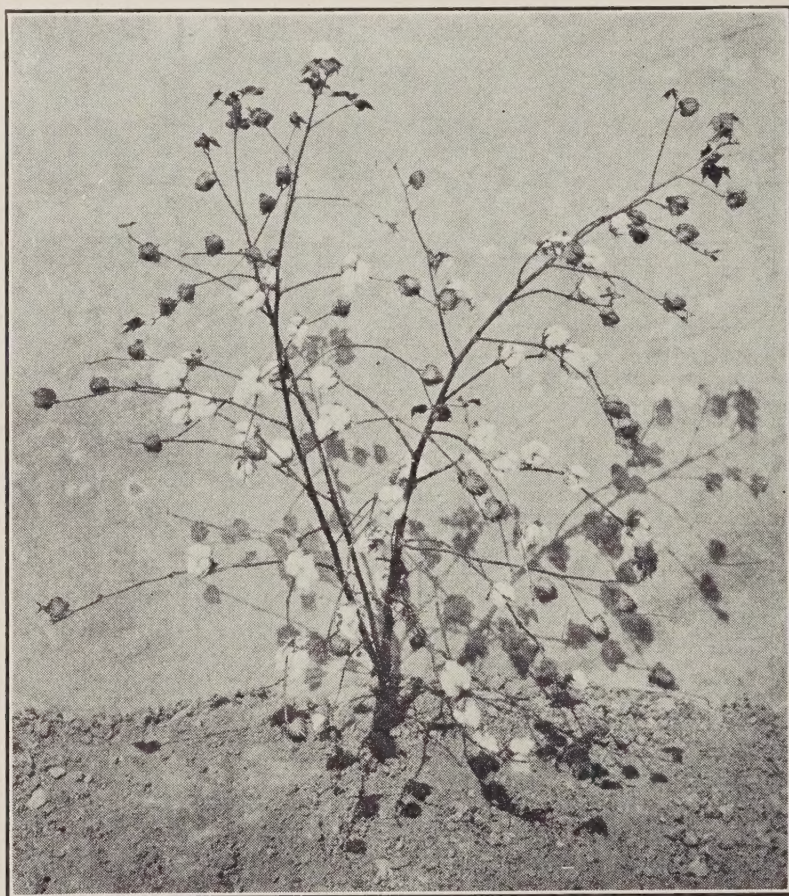


FIG. 19. — Plant of Durango cotton. (Courtesy, U. S. Dept. of Agriculture.)

Cook. — This variety is a prolific and vigorous grower. There are a number of strains. The bolls are of medium size and the seed cotton is easily picked. The variety produces good yields and the percentage of lint is very high, sometimes exceeding 40 per cent. The lint is less than an inch in length. The variety is somewhat susceptible to anthracnose.

Deltatype Webber. — This is a well established variety of long staple Upland. The plants are tall with long fruiting branches. The leaves are medium small, mostly three-lobed, dark green, and young parts hairy. The bolls are large and pointed. About 59 to 63 bolls are required to produce a pound of seed cotton. The lint varies from $1\frac{5}{16}$

to $1\frac{3}{8}$ inches in length, is uniform, strong and silky. The lint is easily picked and the percentage of lint varies from 32 to 34 per cent. The variety is storm resistant.

Hartsville. — A variety with large leaves and large bolls. It is an excellent yielder, storm resistant, and produces a very uniform lint ranging from $1\frac{1}{8}$ to $1\frac{3}{8}$ inches in length. The plants are open, flat topped, and very uniform in type.

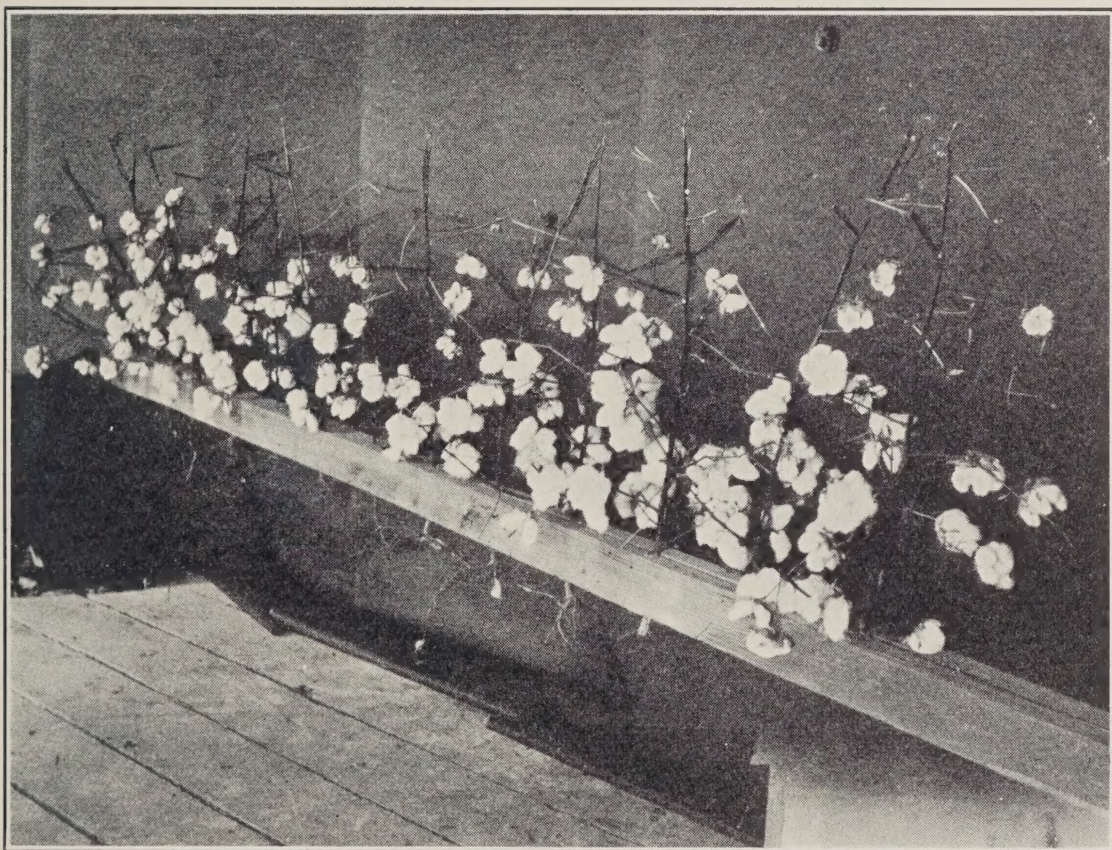


FIG. 20. — A ten-foot section of a row of Super-Seven. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

King. — This is a very early variety. The plants are small. The limbs are slender and short-jointed. The leaves and bolls are small. The flowers are yellow, with purple claws. The seeds are large, coarse, and densely coated with a grayish-white fuzz. The lint is short and the yield relatively low.

Lightning Express. — A very early vigorous growing variety of cotton. The plants are open and the foliage thin. The bolls are of medium size and the seed cotton is easily picked. The staple ranges from $1\frac{3}{16}$ to $1\frac{1}{4}$ inches in length. The percentage of lint ranges from 30 to 33 per cent.

Rowden. — A medium early maturing variety. The plants are short. The limbs are of medium length and the bolls are ovate, pointed, and hang down when open. The average percentage of lint is about 34 per cent.

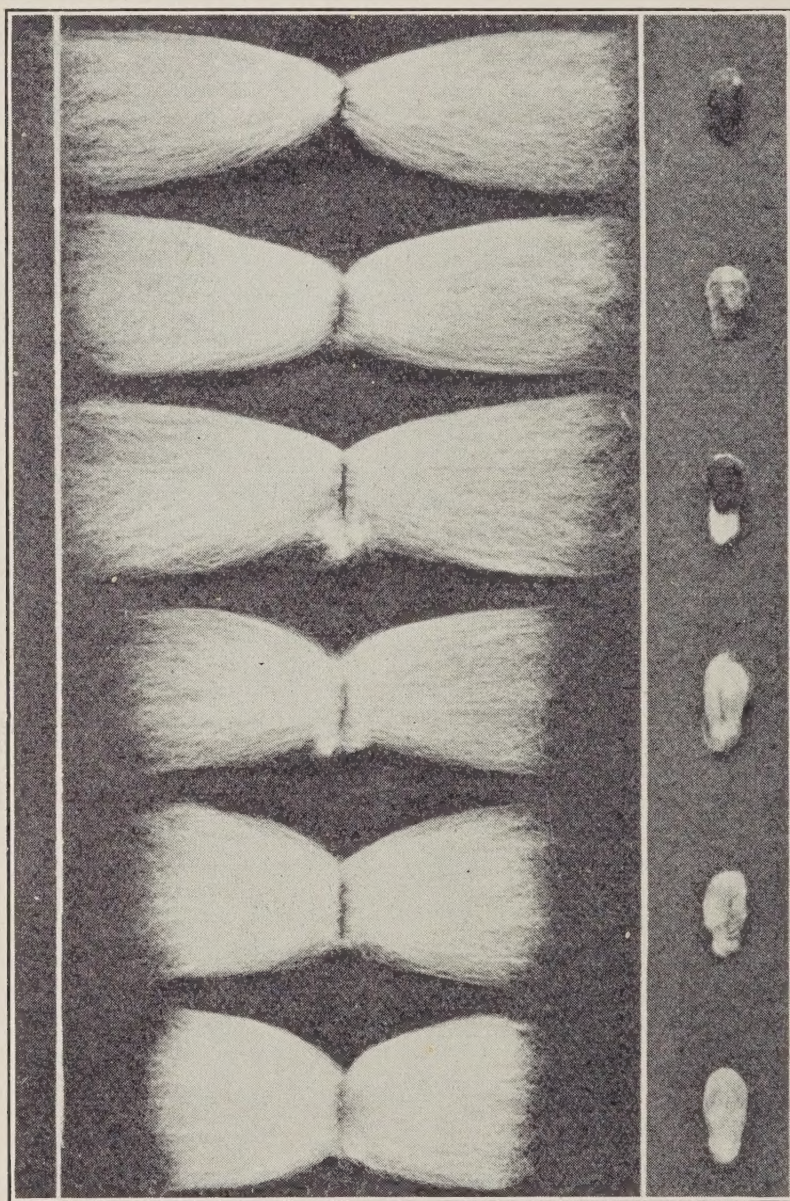


FIG. 21. — Varieties in order from top. Sea Island, Egyptian (Pima), Meade, Durango, Acala, and Lone Star. (Courtesy, U. S. Dept. of Agriculture.)

Triumph or Mebane. — An early to medium maturing variety. The leaves are large and five-lobed. The bolls are large and the seed cotton is easy to pick. The average length of lint is about 1 inch. The uniformity may be considered as only fair. The percentage of lint is rather high.

Dixie. — A wilt-resistant plant with large basal branches. The fruiting limbs are slender and long, leaves and bolls of medium size. Seventy-six bolls are required to make one pound of seed cotton. Seeds are small and covered with a greenish-brown fuzz. The length of lint is about $1\frac{1}{8}$ inches and the percentage of lint to seed is about 34 per cent.

Dillon. — A tall, wilt-resistant plant with one, two, or three basal branches. The leaves are of medium size. Eighty bolls are required to yield one pound of seed cotton. Seeds are small and covered with a dense brownish-green fuzz. The length of lint varies from $\frac{7}{8}$ to 1 inch. Percentage of lint to seed cotton is about 37 per cent.



FIG. 22. — Bales of short staple and Meade cotton. A bale of Meade cotton (at right) weighing 400 pounds, compared with the usual 500-pound bale of short staple cotton. The Meade bale is completely covered by strong burlap and is sold on sample at the gin, thus affording complete protection for the fiber. (Courtesy, U. S. Dept. of Agriculture.)

Varieties of Cotton Most Commonly Grown. — Varieties of cotton vary in their popularity from year to year, and for that reason one variety of cotton may be grown one year to a greater extent than the next. At the present time the most popular varieties producing a length of staple under $1\frac{1}{8}$ inches are the Cleveland, Triumph or Mebane, Mexican, Lone Star, Cook, Simpkins, Rowden, King, Trice. Those producing a staple between $1\frac{1}{8}$ and $1\frac{1}{4}$ are Webber, Express, Toole, Lightning Express, Delfos, Dixie, Durango, and Acala. Those producing a staple

54 CLASSIFICATION OF AMERICAN UPLAND COTTON VARIETIES

over $1\frac{1}{4}$ inches are Hartsville, Deltatype Webber, Webber, Meade, Pima and Yuma Egyptian, and Sea Island cotton.

REFERENCES

1. Ayres, W. E. Varieties of cotton. Arkansas Exp. Sta., Bul. 157, 1918.
2. Brown, H. B., *et al.* Cotton experiments in 1915. Mississippi Exp. Sta., Bul. 173, 1916.
3. Bennett, R. L. Cotton investigations of the Bur. of Plant Industry, U. S. Dept. of Agriculture and the Texas Exp. Station; Early cottons. Texas Exp. Sta., Bul. 75, 1904.
4. Duggar, J. F. Descriptions and classification of varieties of American Upland cotton. Alabama Exp. Sta., Bul. 140, 1907.
5. Rast, L. E. Cotton varieties in Georgia. Georgia Extension Bul. 121, 1917.
6. Ricks, J. R. Cotton experiments in 1916. Mississippi Exp. Sta., Bul. 178, 1916.
7. Meade, Rowland. Meade cotton. Science, N. Ser. 47, No. 1227, pp. 11, 12, 1918.

CHAPTER VIII

CULTURE OF COTTON

The cultural practices employed in the production of cotton are, on the whole, very poor. The primary cause of this lies in the lack of soil education on the part of the average cotton grower. In order to remedy this condition the farmer must be taught the principles and fundamentals of soil physics and fertility upon which he can base his cultural practices instead of depending upon custom as his guide, as he has done in the past.

Time of Plowing. — The process of plowing, in preparation for cotton, varies widely, depending upon custom more than anything else, but being influenced to a great extent by soil conditions and prevalent systems of rotations. Spring plowing is much more general than fall plowing, most of it being done in the months of February and March. However, spring plowing does not always give the best results. The greater the per cent of clay in a soil the earlier the plowing should be done. Sandy soils should not be plowed in the fall because of the excessive leaching out of the plant food elements that will occur. If large amounts of cotton stalks or litter of any kind are to be turned under, fall plowing is advised in order that the decay of these materials may be hastened. The turning under of cotton plants before frost has been advocated as a control measure in fighting the boll weevil. Where winter cover crops are on the land previous to cotton, they should be turned under as early in the spring as possible. Fall plowing is especially recommended as an aid in the control of certain insects and diseases, as the turning up of the soil exposes them to the weathering agents. The action of weathering agents upon the soil during the winter also aids in the breaking down, and the making available for plant use, of the insoluble compounds of the soil which contain the plant food elements. This action may be either beneficial or detrimental to the yield of cotton in the following year. On rich bottom lands, or on some of the soils of the Black Prairie region of central Alabama, this increase of the soluble plant food elements may cause an excess of vegetative growth which will delay the fruiting of the cotton and thus reduce the yield. On poor soils this increase in soluble plant food

elements may act beneficially, producing an increased growth, but not an excessive vegetative growth, thus increasing the yield.

Preparation of the Land for Plowing. — Where cotton follows cotton, under boll weevil conditions, the plants should be turned under before frost and a cover crop planted, but preparatory plowing for the next year's cotton should be done early enough the following spring to allow the seedbed to settle before planting. The first step in the preparation



FIG. 23. — A common method of preparing land for cotton. (Courtesy, The National Fertilizer Association.)

of the land for cotton, where cotton follows cotton, which is the most common practice, is to clear off the dead stalks of the previous year, or to break them into small sections in order that they may be turned under easily. It is nearly always preferable to plow under, — and not burn, as is so often done, — the cotton stalks, or any other organic litter for that matter, in order that the much needed organic matter of the soil may be augmented. The stalks may be broken up, either by running a drag over them or by flailing them with heavy sticks during periods of weather conditions when the plants are brittle, or by running a stalk cutter over them. The last named process is to be preferred.

Plowing Practices. — The most common practice of plowing in the Cotton Belt is to plow the field into alternate rows of back-furrows and water-furrows. In regions of rolling topography these rows are run across the field at right angles to the slope. The back-furrows are spoken of as the “beds” and the water-furrows as the “middles.” When cotton follows cotton the most common form of preparing the beds is as follows: A one-horse plow is run along the side of the old cotton row and the soil is thrown toward the middle by running one,

and sometimes two, furrows on each side of the row. The central part of the ridge thus formed is called the "balk." This is then broken out with a plow called a "middle buster," or "scooter," leaving a furrow in which the commercial fertilizer, manure, or compost is distributed. The distribution of the fertilizer is accomplished usually by means of a one-horse fertilizer distributor which also mixes the soil with the fertilizer. The soil is then bedded back on the fertilizer, leaving another balk between the two old rows, which may be left until the cotton is cultivated. The beds are then leveled somewhat and the cotton planted in the same row as the old cotton. In this way the cotton receives the residual effects, if any, of the fertilizer of the previous year. In the western part of the Cotton Belt, where the land is nearly level, and where no fertilizer is used, the beds are made with a four-horse "middle-buster." The beds are made in the middles of the previous year. If the stalks have not already been removed they are raked and burned. The beds are lowered with a harrow.



FIG. 24. — Plowing cotton land with four horses to the plow. (Courtesy, The National Fertilizer Association.)

A better practice, and one which is being used to an increasing extent, is to plow the land "broadcast" or "flushed." By this is meant that the furrow slices are all thrown in the same direction. After this method of plowing the method of throwing up the beds as above described can be followed. Of course, this increases the amount of labor required, but the seedbed will be more thoroughly prepared. Where fall plowing

is practiced, the beds are not made and the fertilizer is not applied until the following spring.

Depth of Plowing. — Soils should always be plowed deeper in the fall than in the spring. Clay soils, as a general rule, should be plowed deeper than sandy soils. Deep plowing should always be done when possible. However, deep plowing should not be done on soils upon which this method has not in past years been the practice. Nevertheless, deep plowing can be inaugurated gradually by increasing the depth of plowing year by year, say one to one and one-half inches a year until the desired depth is reached. The purpose of this gradual deepening is to prevent bringing too suddenly to the surface a large amount of sub-soil. If large amounts of sub-soil are brought to the surface the physical and chemical condition of the soil is greatly injured and consequently the yield of cotton is greatly reduced. The ultimate aim, where fall plowing is practiced, should be to plow all soils to a depth of eight inches.

Sub-soiling. — In some sections a process known as sub-soiling is practiced. This process consists in the breaking up of the sub-soil,

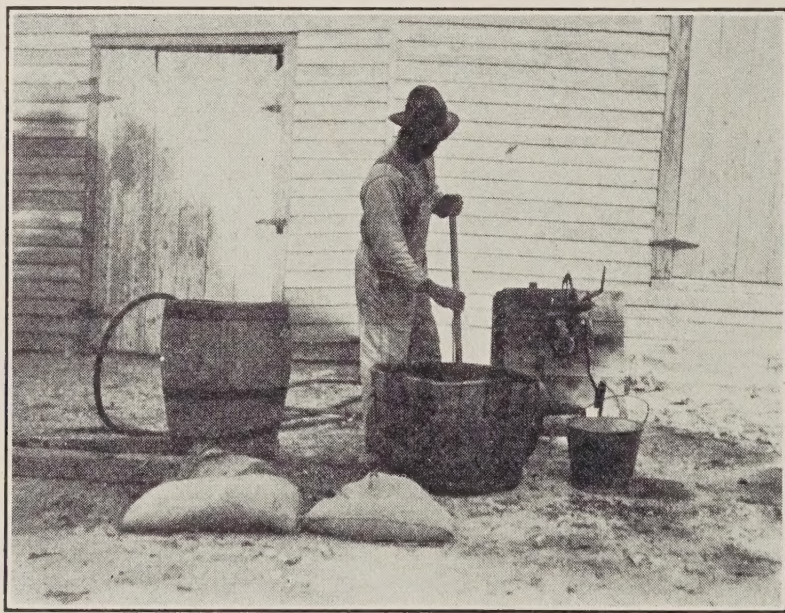


FIG. 25. — Delinting cotton seed with sulphuric acid. (Courtesy, South Carolina Experiment Station.)

thus allowing the entrance of water and air. This is done through the use of a plow which has no moldboard, known as a sub-soil plow. By the use of such a plow the sub-soil does not become mixed with the surface soil. If the soil is too much saturated with water a puddled condition is likely to be produced which will result in a far worse condition than the sub-soils of most of the Cotton Belt are found in. Where

hardpans are prevalent, sub-soiling may eradicate them, but on some types of clay soils the value of sub-soiling with the plow, just as the value of sub-soiling with dynamite, is of short duration, for the soil particles run together again upon becoming saturated. Sub-soiling should be done in the fall, so that time will be given for settling and firming before spring. If sub-soiling is done in the spring, time is not given for the settling of the soil, and air spaces will be left in the sub-soil, thus cutting off capillary moisture from the surface soil. Seedbeds prepared on such soils will be too loose, and of a too droughty nature, for the production of cotton. Under average conditions sub-soiling is not to be recommended.

Dynamiting. — In 1913 the Georgia Experiment Station dynamited one and one-half acres of land at a cost of \$16.80. The charges were put in fifteen feet each way and two and one-half to three feet deep. This land produced 1864 pounds of seed cotton per acre, which was 126 pounds more than was produced on a similar plat which had not been dynamited. It is very improbable that the practice will ever be made a paying proposition.

Preparation of the Seedbed. — The need of a well pulverized, firm seedbed cannot be too strongly emphasized. There is a saying that cotton will not grow off well until the roots strike hard ground. Upon this same belief may be laid, to some extent at least, the blame for the practice of shallow plowing. The seed are planted in the center of the beds. The bed may be left slightly above the middles, or it may be harrowed down level with the middles. The level cultivation is coming to be more used, but custom still reigns supreme over the greater part of the Cotton Belt, and the practice in most sections is to plant the seed on ridges or raised beds. It is claimed by the adherents to this method that the soil warms up earlier in the spring, and that the middles furnish a good system of drainage which prevents excessive washing, and yet removes sufficient water to prevent "drowning out" of the plants during wet weather. The greatest objections to this method are the extra labor required to build the beds, and the excessive drying out that must eventually take place where an increase of the surface area of the soil is made. The bedding process is not necessary, and is rarely employed in the western part of the Cotton Belt, or on well drained sandy soils in other sections. Where the bedding process is employed, the beds should be made at least fifteen days prior to planting, in order to allow the soil to settle and warm up. On the heavier types of clay soils, which are naturally cold, twenty to thirty days should be allowed.

Width of Rows. — The width of rows usually employed varies from two and one-half to five feet. On poor soils three feet is the most

common width, and on rich soils five feet. Unlike the spacing of corn, the poorer the land the closer together the plants are placed, and the richer the soil the farther apart. This is explained by the fact that rich soils produce a larger plant, which requires a larger space for its development.

Purchase of Seed. — It has been estimated that approximately 500,000 tons, or a billion pounds, of seed are necessary to plant the average cotton acreage of the United States. This means that about one-tenth of the average total amount produced is used for seeding purposes. It has also been estimated that about 30 per cent of the total planting requirement is obtained by farmers from commercial sources. Where seed is bought great care should be taken to secure good planting seed. Such seed may be described as seed selected from cotton that is true to type, pure of variety, well matured, free from disease and insects, or insect injury, delinted, recleaned and graded, and testing a minimum of 88 per cent germination.

The shipping tag should give the following information: variety, lot number, where grown, year grown, percentage of germination, and date of test. As the legal weight per bushel of cotton seed varies with the different states, and as cotton seed itself varies in weight depending upon percentage of moisture, percentage of linters, variety, etc., all transactions should be based, if possible, upon the 100 pound unit rather than upon that of the bushel.



FIG. 26. — Cotton seed delinted with sulphuric acid and cotton seed not delinted. (Courtesy, South Carolina Experiment Station.)

Delinting Cotton Seed for Planting. — The value, cost, and method of delinting cotton seed are clearly brought out in the following recommendations of the Agronomy Division of the Clemson Agricultural College to the farmers of South Carolina in 1925 and 1926.

"The practice of delinting cotton seed before planting is getting to be more general every year. Such a step is necessary if farmers wish to obtain stands of cotton in shorter periods of time than are to be expected when common or undelinted seed are used. Delinted seed are freed of the excess fuzz or linters on the seed coat, making it possible for the moisture in the soil to come directly in contact with the seed proper as soon as planted, thereby hastening germination and resulting in an earlier stand of cotton.

"Two general methods are used in delinting cotton seed: (1) delinting by machinery at oil mills, and (2) delinting by the use of commercial sulfuric acid. Both methods are good but the acid process is probably the better and the one most generally recommended. In treating seed with acid, not only is the lint removed but certain plant diseases which become attached to the lint, such as angular leaf spot and anthracnose, are destroyed during the process.

"The following carefully conducted experiments in 1923, 1924, and 1925 gave the following results:

"AVERAGE YIELDS WITH GAIN OR LOSS FROM METHODS OF SEED TREATMENT. EXPERIMENTS CONDUCTED AT FLORENCE, S. C.

Treatment	Days necessary to obtain stand 3-yr. average	Average yield pounds seed cotton per acre 3-yr. average	Average gain or loss from treatment
Normal seed.....	9	1531	.....
Delinted with acid.....	17	1678	+147
Delinted with machine.....	19	1604	+73
Rolled in soda.....	23	1518	-13

"Delinting Cotton Seed with Commercial Sulfuric Acid (66 degrees Baumé)

"Material Needed. — Concentrated sulfuric acid, about 7 to 9 pounds for each bushel of seed. The quantity needed will depend somewhat on amount of lint and fuzz on seed. Two wooden tubs. One wooden stirring paddle. Plenty of water at hand.

"Directions for Treating Seed. — Fill first tub about half full of seed and add acid slowly, stirring seed with paddle until lint is removed. Use just enough acid to remove lint. Next empty seed into second tub, which should have an opening in bottom or side covered with copper gauze, or perforations which will allow water to pass through, but retain the seed. Wash the seed in this tub with water several times, until free from acid. If a good stream of running water is applied, this does not take long. The seed should then be spread on the floor or on sheets in the sun to dry. As soon as dry they are ready for planting.

Cautions. — 1. Wooden tubs must be tight and substantial before beginning. Tubs which require to be tightened by swelling with water will not do as the acid takes all the water out of the wood.

2. Acid must be handled with care, as it will eat holes in clothing with which it comes in contact.

3. Seed treated with sulfuric acid will run through the planter much more freely than will the undelinted seed, hence, precautions must be taken to close planter so as not to drill seed too heavily.

Costs. — In 1924 the Clemson College Farm obtained its supply of acid from the Grasselli Chemical Co., Birmingham, Alabama, at a cost of about two cents per pound, and the freight was approximately one cent per pound, making the total cost at Clemson College approximately three cents per pound. The amount for delinting one bushel of seed, therefore, cost about 25 cents."

Results at Florence, S. C., have also shown that plants on the acid-delinted plots have begun blooming first and have continued fruiting most rapidly early in the season, although the total production of flowers for the acid-delinted and the non-delinted groups remained about the



FIG. 27. — A field of cotton a few days old. (Courtesy, North Carolina Experiment Station.)

same. Likewise, the total yield at the first picking was greatest for the acid-delinted plots.

An excellent method of grading delinted seed is to fill a tub about half full of seed, and then fill the tub with water. The seed should then

be thoroughly stirred with a paddle and the light, immature seed skimmed off the surface and discarded.

Planting the Seed. — Planting should be done as soon as all danger from frost is past. A common practice in pre-boll weevil days was to wait two weeks after the average date of the last killing frost. Available data indicate that this rule will be satisfactory for boll weevil conditions. The seed are drilled, usually with a single-horse planter, although in some sections of level topography a double-horse planter may be used. These planters open up a furrow, drop the seed, and cover them. There are several types of these planters on the market today, most of them designed primarily to plant non-delinted seed. Corn planters may be modified satisfactorily to plant delinted seed. In some planters the distance of planting within the row may be regulated, although they may require that the seed be treated in some way in order that the bunching together, which is so characteristic of cotton seed because of the fuzz on the seed, may be eliminated. This fuzz may be prevented from holding the seed together by dampening the seed and then rolling them in ashes, "soda," or fine dust, or the fuzz may be entirely removed by treating the seed with strong sulfuric acid. When the seed are rolled in ashes, "soda," or dust, germination is delayed a few days.

Quantity of Seed to Plant. — The quantity of seed planted per acre varies, as do all other methods and practices of cotton production. As a general practice, from one to one and one-half bushels of seed are planted per acre. A bushel of seed contains from 90,000 to 200,000 seeds, and as only about 12,000 plants are usually left per acre, about fifteen times as many seed are planted as plants required. This common practice of planting an excess quantity of seed is due somewhat to the cheapness of the seed in former years, and to the necessity of planting large quantities of seed in order to keep the drill running continuously, which was necessary with the old planters. A smaller quantity of seed may be planted when the better types of planters are used, but not less than one-half bushel of good seed is recommended. The planting of an excess quantity does, however, eliminate the loss due to poor germination, and allows the weak plants to be weeded out after they come up. On the heavier types of clay soils, where a crust is easily formed, the large number of seed germinating at the same time are able through their combined action to break the crust, which could not be done if the seed were planted sparsely. In some communities the planting of cotton in check rows is practiced. This method saves labor, but requires level planting on fertile, well drained soil of nearly level topography.

Comparison of Heavy Separated Seed and Unseparated Seed. — The United States Department of Agriculture found in a test of the comparison of the yield produced from heavy seed that had been separated out of the general crop seed, and the yield of plants from unseparated seed, that in the case of the Hawkins variety the heavy seed produced 10.9 per cent more seed cotton per acre, and in the case of the Hartsville variety, 8.25 per cent more seed cotton per acre than the unseparated seed.



FIG. 28. — A chopping scene. (Courtesy, U. S. Dept. of Agriculture.)

Time of Planting. — In the extreme southern part of the Cotton Belt cotton is planted as early as March 20, the season advancing northward at the rate of ten to twenty miles a day. Planting is usually begun in the central part of the Cotton Belt about April 1 to the 7, and in the northern part about April 20. It usually takes two to three weeks to complete the planting, so that in the extreme southern part of the Cotton Belt planting has been completed by April 20, and in the northern part of the Cotton Belt one month later. The planter should be set so that the seed will be covered shallow, especially when planted early. Some farmers claim that a good stand will not be secured unless a large number of the seed can be seen uncovered after the

planting has been done. Germination may be hastened considerably by treating the seed with sulphuric acid.

Early Cultivation and Chopping. — As soon as the plants are up they are harrowed with a one-horse harrow, one side at a time; or by removing the center tooth of the harrow the rows may be straddled. As soon as the cotton has been harrowed the expensive process of chopping begins. This process is done by hand labor. Although implements have been made to do this work, none has proved entirely satisfactory thus far. Men, women, and children are hired to do this work, but usually mostly women. They pass down the row and cut out the plants with a hoe to the desired distance. Sometimes two plants are left together until they have grown larger and have passed the most dangerous stage of their existence and then one is removed. It is claimed by some farmers that larger yields may be secured when two plants instead of one are left to a hill at the final thinning. There is usually a considerable variation in the size and age of the young cotton plant when chopping is begun in the different sections of the Cotton Belt. The Georgia Agricultural Experiment Station, under non-boll weevil conditions, secured the following results from a five-year test of early against late chopping of cotton. The results of these experiments show that the loss due to late chopping is about 6.8 per cent. The late chopping, however, yielded a slightly earlier crop.

EARLY AGAINST LATE CHOPPING AT THE GEORGIA AGRICULTURAL EXPERIMENT STATION

Chopping date	Variety	Early	Late
		Lbs.	Lbs.
1914.....	Durango	766	638
1916.....	Sunbeam	1850	1878
1917.....	Lewis 63	1390	1265
1917.....	Sunbeam	1585	1521
1918.....	Sunbeam	1109	1041
Average.....		1340	1248

Early chopping also appears to give the best results under boll weevil conditions judging from the following two-year results secured by the South Carolina Agricultural Experiment Station.

YEARLY AND AVERAGE YIELDS FOR EARLY AND LATE THINNING

Time thinned	Yield pounds seed-cotton per acre 1923	Yield pounds seed-cotton per acre 1924	Average yield pounds seed- cotton per acre
Early.....	733	670	702
Delayed.....	607	548	578

The distance that should be allowed between the plants within the row, like the distance between the rows, will depend upon the soil and climatic conditions, as well as upon the type of plant. The most com-



FIG. 29. — A common method of cultivating cotton.

mon distance used in the row is from six to twelve inches. From North Carolina to Texas close spacing has given best results. The following tables, selected rather at random from a large number of similar studies, show this to be true. These tables are taken from Mississippi Bulletin 186, page 17; from Arkansas Bulletin 153, page 4, and South Carolina Bulletin 219, page 36, respectively.

RESULTS OF SPACING WORK AS SUMMARIZED BY THE ARKANSAS EXPERIMENT STATION IN 1918

State	Width of rows in inches	Number of tests	Number of inches between hills					
			12	16	20	24	30	36
			Pounds seed cotton					
Mississippi.....	48	6	1644			1459	1336	1222
Mississippi.....	44	4	1801		1590	1569		
Georgia.....	48	3	1741	1644	1662	1781		
Georgia.....	48	7	1873			796	711	1786
Alabama.....	42	2	846			909		697
North Carolina (1).....	39.6	5	1052	984	932	817		
North Carolina (1).....	49.5	5	951	939	877			
North Carolina (2).....	42	4	1482	1525	1400	1459		
North Carolina (2).....	48	3	1709	1726	1510	1556		
North Carolina (3).....	42	4	808	811	820	873		
North Carolina (3).....	48	3	960	989	874	839		
North Carolina (4).....	42	4	938	1106	1015	994		
North Carolina (4).....	48	4	1004	927	883	873		
Louisiana.....		1	1660	1800	1753	1800		
								1645

(1) Experiment Station. (2) Edgecomb Farm. (3) Red Spring Farm. (4) Iredell Farm.

COTTON SPACING TEST CONDUCTED IN 1918 AT THE HOLLY SPRINGS STATION,
MISSISSIPPI

Varieties	3-foot rows 9 inches in drill	3-foot rows 12 inches in drill	4-foot rows 9 inches in drill	4-foot rows 12 inches in drill
	Pounds seed-cotton	Pounds seed-cotton	Pounds seed-cotton	Pounds seed-cotton
Wannamaker-Cleveland....	1400	1320	1239	1096
Cleveland Big Boll.....	1435	1216	1107	1128
Sherard's Columbia.....	1330	1140	1036	990
Average per Plat.....	1388	1240	1127	1071

RESULTS OF SPACING TEST AT PEE DEE EXPERIMENT STATION, FLORENCE,
S. C., 1922

Spacing in row	3-ft. row	3½-ft. row	4-ft. row	4½-ft. row	5-ft. row	Aver- age
Unthinned.....	680	790	750	732	746	740
3 inches.....	740	790	810	746	672	752
6 inches.....	820	756	720	680	624	720
8 inches.....	700	738	840	800	624	740
12 inches.....	660	721	790	760	516	689
16 inches.....	680	687	765	746	516	679
Average.....	713	747	779	744	616	

Results secured at the South Carolina Agricultural Experiment Station indicate that the best spacing is that which leaves 15,000 to 20,000 plants per acre. These results also appear to indicate that within reasonable limits the actual spacing in the row does not play such an important part, provided the plants are well distributed. Close spacing gave an earlier crop and generally a higher yield. It also produced a slightly smaller boll, but it had no effect on the ginning percentage.

Cotton is often hoed one or two times after chopping.

In some sections a weeder, or, more commonly, a spike-tooth harrow, is being used more and more to break the crust of the soil before the seedlings break through, and also after the plants get up. They are

usually run across the rows with the teeth of the harrow set at a slant, and in this way help to clean out the small weeds that are coming up next to the cotton. It is true that some of the cotton plants are pulled out, but where the usual quantities of cotton seed are planted this damage amounts to very little, if any, while the labor required in chopping may be decreased.

In some localities the first cultivation is not made until two to four weeks after planting, the plants being from about four to six inches high by this time. Then the rows are "barred off." This consists in running a one-horse turn plow close to the plants and throwing the



FIG. 30. — A terraced cotton field. Terracing is a common method of preventing erosion in regions of rolling topography.

soil toward the middle. The cotton is then chopped and "four-furrowed." The last named process consists in going twice around each row and throwing the soil toward the plants. The third and subsequent cultivations are so made that the middles are not furrowed or ridged. Double cultivators are coming to be more commonly used until the plants get so large that it is necessary to resort to single cultivators.

Single Stalk Cotton Culture. — As a result of some experiments carried on by the Bureau of Plant Industry, of the United States Department of Agriculture, a system of cotton culture based on the control of vegetative branches by methods of thinning was advocated in 1913. It was claimed that the number and size of the vegetative branches could be controlled by postponing the chopping period until the stalks

passed a certain period of vegetative branch formation. It was also claimed that by following this method more plants could be left in the row, and yet the injurious results of crowding be eliminated by the previous suppression of the vegetative branches; that the fruiting branches developed earlier, and consequently produced an earlier crop. This system was particularly advocated for regions of a short growing season, and for boll weevil territory where earliness was to be emphasized. Since 1914 this method has been tried out in a number of localities in all parts of the Cotton Belt, and an increased yield and earliness have been noted. Whether this increase in yield and earliness is due to late thinning or to the close spacing is a debatable question. The latter is more probably correct for all sections except the American-Egyptian belt.

Number of Cultivations. — The number of cultivations that cotton should receive after chopping varies. At least five cultivations are recommended by most farmers for rich soils, and six to seven for poor soils. A common rule which is followed is to cultivate after every rain. The cultivations should be made more and more shallow as the season progresses, in order that as little damage as possible will be done to the root systems. In some sections the alternate middles are cultivated each week, making a complete cultivation every two weeks. In the western part of the Cotton Belt the last cultivation is made about the middle of July, in the eastern part about the first of August.

Side Application of Fertilizers. — A common practice in some sections is to apply only a portion of the fertilizer when the beds are made, and the other portion as side dressings at the second or third cultivation. Where nitrate of soda is applied it should be put on not later than about two weeks after the chopping out process, in order that the increased vegetative growth resulting from its use may not come so late that late maturity will result. Under boll weevil conditions late application of fertilizers must be done away with entirely.

Value of Cultivation. — It should be kept in mind, that the purpose of cultivation is three-fold: first, to kill weeds; second, to increase nitrification; third, to conserve moisture. The earlier cultivations kill the weeds and help to conserve moisture. All cultivations increase nitrification, thereby increasing the amount of available nitrogen in the soil, but an increase in the available nitrogen is not needed in all soils, and in some cases may do more harm than good. As a general thing late cultivations are certainly not needed to kill weeds, because the cotton plants have grown to such a size by this time that most weeds have been choked out. Furthermore, late cultivation often does harm by breaking off the roots. A particularly debatable question

which remains to be settled, and concerning which very little is now known, is the value of late cultivation in the conserving of the moisture supply. Experimental work with corn in some sections of the country has shown that a soil mulch is not necessary after a network of roots has been formed in the middle of the rows, as they absorb and thereby prevent most of the capillary water from reaching the surface, and



FIG. 31. — A farmer returning home from a ginnery with a bale of cotton.

that the late cultivations of corn may be omitted. This may be true with cotton. Certainly, if the later cultivations are not needed to kill weeds, and if their influence upon nitrification is not needed, and if they do not conserve moisture, they are valueless, and thousands of dollars may as well be saved by the cotton growers as expended in useless cultivation. Some results that have been secured by the South Carolina Station, as to the value of cultivation, are given on page 72.

Pruning. — Considerable interest has been shown during the last few years in what is known as the Florida method of boll weevil control. Under this system the cotton is planted late and all the early squares are stripped from the plant. Such a practice is supposed to aid materially in reducing the number of weevils which attack the plant during the latter part of the season. The South Carolina Experiment Station

YIELDS OF SEED COTTON IN CULTURE TEST AT CLEMSON COLLEGE, S. C.,
1920-1923

Cultivation	1920	1922	1923	Average
Normal cultivation.....	680	931	1165	925
Normal cultivation plus two extra cultivations.....	754	831	1034	873
No cultivation (Weeds scraped off with hoe)	666	1000	1000	889

found that pruning off the early squares stimulated the plant to further square formation. A net loss, however, was noted, for the non-pruned plants contained more bolls on the first of September than did the



FIG. 32. — An example of the good roads that are found in the more prosperous cotton-growing communities.

pruned plants. It was also noted that the pruning of the squares did not influence the time required for flower or boll formation.

Topping. — In some sections of the Cotton Belt, before the appearance of the boll weevil, a practice which is known as topping was em-

ployed. Topping consists in the removal of the top buds of the plant in order that the vegetative portion of the plant may not grow to such a size that the fruiting portion will suffer therefrom. The results of the many experiments which have been conducted to determine the value of this practice are variable. The majority of the results, however, tend to indicate that the practice is detrimental.

Since the entrance of the boll weevil the practice has proved especially detrimental as it removes the portion of the plant that produces the food upon which the weevil should feed during the latter part of the growing season. The practice also leads to an increase in the foliage and thus may lead to an increase in boll rot diseases.

Cultivation of Sea Island Cotton. — On the islands and mainland of South Carolina and Georgia, where Sea Island cotton was formerly grown, the practices of cultivation were similar to, although in some details different from, the cultivation of Upland cotton. Large quantities of compost, as well as commercial fertilizers, were used. When the plants were well up they were cultivated with various forms of sweeps, and then hoed. The hoe was used to a far greater extent than it is in the cultivation of Upland cotton. The cotton was worked every week when possible, eight to ten cultivations being made in all.

Rotations for Cotton. — There are numbers of rotations containing cotton that have proved successful in the Cotton Belt. However, no one rotation is adapted to all localities. The variability of soil, climatic and economic conditions throughout the South accounts, to some extent at least, for the large number of rotations practiced. The following rotations are representative of the various rotations now in common use throughout the Cotton Belt:

- I. First year — cotton.
Second year — corn with cowpeas or velvet beans; small grain.
Third year — small grain; cowpeas or sorghum.
- II. Cotton continuously with annual vetch between crops.
- III. First year — cotton.
Second year — cowpeas, peanuts, or soybeans.
Third year — corn.
Fourth year — tobacco.
- IV. For wilt infested land:
First year — wilt resistant cotton; oats.
Second year — oats; Iron, Brabham, or Monetta cowpeas.
Third year — corn and velvet beans.
Fourth year — peanuts.

The greatest objection that can be made to most of the rotations now in use is that not enough attention has been given to green manuring and winter cover crops. It is the object among the better class of farmers to keep the land covered with a growing crop during every month of the year. The average rotation followed is usually three years in length, but four or five-year rotations are often followed when cotton or corn is grown for more than one year in the rotation, or when such other cash crops as tobacco and peanuts are added to the common three-year rotation.



FIG. 33. — A prosperous and well laid out cotton plantation. (Photograph by J. Horace McFarlane Company, Harrisburg, Pa.)

Cultural Practices Followed in Various Sections of the Cotton Belt. — As has been said, there is a wide variation in the cultural practices employed in different sections of the Cotton Belt. This is shown in the following surveys of the common cultural practices in representative counties of five different sections of the Cotton Belt, as reported in United States Department of Agriculture Bulletin 511.

" SURVEY IN ELLIS COUNTY, TEXAS

" Ellis County is located in the northeastern part of Texas. The tillage records for this county were taken near Waxahachie. This is one of the most prosperous farming counties in the State. The soils are exceptionally fertile and the seasons are usually favorable.

" Improved labor-saving machinery is largely employed within this county which enables one man to work 40 to 50 acres of cotton with the exception of chopping to a stand and harvesting the crop. For this extra work negro labor is secured in the cities; men, women, and children come out in parties and live in tents while doing this work.

" Through the central part of the country runs a broad belt of Houston black-clay soil. This is a prairie region, with broad, gently rolling land that requires very little drainage. In this belt 80 per cent of the cultivated land is in cotton annually.

" In preparing the land for cotton heavy teams and large implements are used. During the late winter or early spring the land is plowed with a 4-horse middle buster, or lister. The old cotton stalks are plowed up and the land thrown into beds the width apart the cotton rows are to be. With this implement only one furrow is required for each row. If the stalks are rank, they are cut up with a stalk cutter before plowing or are raked up after plowing and burned. Before planting, these beds are harrowed once with a spike-tooth harrow.

" Cotton is planted with a 2-horse 1-row lister planter. This planter has a broad shovel which tears down the bed and leaves the cotton planted almost level with the surface. The cotton rows average 3 feet apart, and 2 to 3 pecks of seeds are planted per acre. After thinning, the stalks are left from 12 to 15 inches apart in the drill.

" After planting, all the cultivating is done with a 2-horse 1-row 2-shovel cultivator equipped with buzzard-wing sweeps instead of shovels. For the first cultivation, which is given ten days or two weeks after planting, small 6-inch or 8-inch sweeps are used next to the cotton and 10-inch or 12-inch sweeps on the outside. The cotton is chopped to a stand after the first cultivation and gone over with a hoe once or twice later in the season, to chop out any extra stalks and weeds. For later cultivations 12, 14, and 16-inch sweeps are used on the same cultivator. During the season four or five cultivations are given, and level cultivation is always practiced.

" The most prevalent and troublesome weeds of this county are careless weed, hurrah grass, cocklebur, morning glory, and Johnson grass.

" SURVEY IN JEFFERSON COUNTY, FLORIDA

" Jefferson County is located in the northern part of Florida. The tillage records for this county were taken near Monticello. This is in the Coastal Plain region, and the predominating soil is sand or a sandy loam; the subsoil is clay. The country is level or gently rolling and little drainage is required.

" The land is owned by white men and worked by negro tenants under the supervision of the owner. Very few white men work their own farms.

" The tillage methods employed with cotton are very uniform. If the old cotton or corn stalks are rank, they are cut up with a stalk cutter or chopped off with a hoe, raked up, and burned before the land is plowed. The land is usually plowed in the spring with a 1-horse or 2-horse plow. About half the farmers break the land level and about half plow it into beds of the desired width for the cotton rows. Where the land is broken level the cotton rows are laid off with a fertilizer distributor, which also applies the fertilizer. A bed is then made on this fertilizer with a 1-horse

shovel or turning plow. Where the land is bedded as broken the fertilizer is either applied in the water furrow between the beds and the land rebedded or the fertilizer is applied on top of the bed and no further preparation is given. The soil is of such a nature that harrowing is seldom necessary. Cotton is planted with a 1-horse planter in rows 4 feet apart, and 1 bushel of seed is planted per acre. After thinning, the stalks are left from 12 to 15 inches apart in the drill. For cultivating after planting, 1-horse implements are employed. About ten days or two weeks after planting, the first cultivation is given with a 1-horse turning plow or a 1-horse sweep. A furrow is plowed on each side of the cotton row and the soil thrown away from the



FIG. 34. — Bur clover as a winter cover crop on cotton land. (Courtesy, U. S. Dept. of Agriculture.)

cotton to the middle of the row, leaving the plants on a small narrow ridge. This is known as barring off. After this cultivation, the cotton is chopped to a stand.

“A small 1-horse sweep is employed for the next cultivation. Three furrows are required for each row. The entire middle is plowed out, throwing the soil back to the cotton. After this, larger sweeps are used and only two furrows are required for each row. A few farmers use the 1-horse 5-shovel cultivator and the 1-horse spring-tooth cultivator, but most of the cultivating is done with sweeps, starting with 12-inch or 14-inch sweeps and increasing the size at each cultivation up to 20 or 24 inches. In all, four or five cultivations are given. At the third or fourth cultivation the cotton is again gone over with a hoe and any weeds or extra stalks are chopped out.

"The most prevalent and troublesome weeds are coffee weed, beggarweed, crab-grass, Bermuda grass, and nut-grass.

" SURVEY IN GILES COUNTY, TENNESSEE

"Giles County is located in the south-central part of Tennessee. The topography of this county is very irregular. Parts of it are extremely rolling and rough, while the bottoms and lowlands consist of gentle slopes and low rolling hills. The soil of the upland is a clay loam with a clay subsoil, but the bottom land is a silty loam. The latter lands are drained by open ditches and are exceptionally fertile.

"In preparing a seedbed for cotton, if the previous crop was cotton or corn, the old stalks are sometimes broken up with a stalk cutter or disc harrow. Early in the spring the land is broken level with a 2-horse plow. The land is harrowed with a disc or spike-made harrow, the rows laid off with a 1-horse shovel plow, and a bed made on this row with a turning plow or with a 1-horse sweep. Sometimes the bed is made without laying off the row. These beds are often harrowed with a spike-tooth harrow which smooths off the tops and leaves them almost level with the surface. Cotton is planted on this bed with a 1-horse planter at the rate of 5 pecks of seed per acre. The rows average 3 feet apart. After chopping the stalks are left from 12 to 15 inches in the drill.

"For cultivating after planting, 1-horse implements are principally used. Just after the cotton is up, the first cultivation is given with a 1-horse harrow-tooth cultivator, and generally this implement is used for the second cultivation. Then the cotton is chopped to a stand. After this most of the cultivating is done with a 1-horse 2-shovel cultivator known as a double shovel. This cultivator is equipped with broad shovels or sweeps. Two furrows are required for each row with this tool. A few farmers use a 2-horse 4-shovel cultivator while a few use a 1-horse sweep. A total of five or six cultivations is given during the season. At the third or fourth cultivation the cotton is gone over with a hoe a second time, to chop out any weeds and extra stalks of cotton.

"The most prevalent and troublesome weeds in this county are crab-grass, careless weed, nut-grass, cocklebur, snakeweed, morning glory, and Johnson grass.

" SURVEY IN ROBESON COUNTY, N. C.

"Robeson County is located in the southeastern central part of North Carolina in the Coastal Plain area. The tillage records for this county were taken near Lumberton and Rowland.

"This is a typical cotton section. The country is very flat and in some sections swampy. The soil is a sandy loam with a clay subsoil. It is easily cultivated and where organic matter is added and large quantities of commercial fertilizers are used good crop yields are obtained.

"The tillage methods with cotton in this county are very uniform. The old cotton and corn stalks are cut up during the winter months with a stalk cutter, or disc harrow, or with both. The plowing is done in the spring with 1-horse or 2-horse plows. About half the land is broken level and the other half thrown into beds when broken. If the land is rough or cloddy after breaking a disc harrow is sometimes used, but this is not often necessary. If the land is broken level the rows are laid off with a 1-horse turning plow, using two furrows to the row, or with a 2-horse middle buster or lister, which requires only one furrow. The fertilizer is then placed in the

bottom of this furrow with the distributor (in between the ridges, where the land was bedded as broken) and a ridge made on the fertilizer by throwing a furrow from each side with a turning plow. The cotton is planted on this ridge with a 1-horse planter. The average width of rows is 4 feet, and after thinning, the stalks are left in the rows from 15 to 18 inches apart.

"In cultivating after planting, a weeder or spike-tooth harrow is often used just before or after the cotton comes up. After this practically all the cultivation is done with a 1-horse sweep or scrape.

"For the first cultivation an 8-inch sweep is used, running one furrow on each side of the row. The cotton is then chopped to a stand, leaving one stalk every 15 or 18 inches. For the next cultivation a 12-inch sweep is used and the entire middle plowed out, which requires three furrows for each row. Some farmers use a sweep next to the cotton and break out the middle with a 1-horse shovel plow. After this every other middle is cultivated with the sweep every week, making a complete cultivation every two weeks. Six or seven cultivations are given during the season. The crop is gone over with the hoe again at the third or fourth cultivation, and any weeds or extra cotton stalks are chopped out.



FIG. 35. — A cotton field containing crab grass. Crab grass is one of the most troublesome weeds of cotton. (Courtesy, U. S. Dept. of Agriculture.)

"Heavy applications of commercial fertilizers are used by every farmer visited. The average quantity applied per acre for a cotton crop is 676 pounds. This is usually applied in the drill before planting time, but sometimes two applications are made. When nitrate of soda is used it is applied later in the season.

"The most prevalent and troublesome weeds in this county are crab-grass, cocklebur, snakeweed, and pig-weed.

"SURVEY IN THE MISSISSIPPI DELTA

"The tillage records for the Mississippi Delta were taken in Yazoo County, near Yazoo City, Miss., in Washington County, near Greenville, Miss., and in Sharkey County, near Rolling Fork, Miss.

"In preparing the land for cotton, 2-horse teams are used. After the cotton is picked the old stalks are cut up with a stalk cutter and the land is plowed in the early spring, most of it being bedded as broken. Either a 2-horse turning plow or a lister is used. If the land is not bedded as broken it is bedded before the cotton is planted. If a lister is used for breaking, the beds are plowed up a little higher by running one furrow with a 2-horse turning plow on each side of the bed. These beds are then harrowed down with a spike-tooth harrow until they are only three or four inches high. Sometimes a disc harrow or 1-horse cultivator may be used for leveling down the bed.

"The cotton is planted on this slight bed with a 1-horse planter. The rows are about 4 feet apart and 3 to 4 pecks of seed are planted per acre. When chopped, the stalks are left from 15 to 20 inches apart in the rows.

"Weeds are very troublesome in the Delta, and more cultivation is given cotton here after planting than in any other region surveyed. Just after the cotton comes up it is usually harrowed with a spike-tooth harrow or with a 1-horse harrow-tooth cultivator. After this, cultivators equipped with sweeps are largely used, 1-horse implements predominating. The 1-horse 5-shovel cultivator equipped with small sweeps instead of shovels is the most popular. The 2-horse spring-tooth cultivator and 2-horse 4-shovel cultivator with sweeps and shovels, and the 1-horse 2-shovel cultivator are also extensively used. Cotton is cultivated every week or 10 days during the growing season, a total of 9 to 10 cultivations being given. The crop is chopped to a stand at the second cultivation, and then hoed once or twice more during the season to chop out any weeds and extra stalks of cotton.

"The most prevalent and troublesome weeds in this county are nut-grass, crab-grass, cocklebur, morning glory, Johnson grass, careless weed, and coffee weed."

REFERENCES

1. Ayres, W. E. Cotton spacing experiments. Arkansas Agr. Exp. Sta., Bul. 153, 1918.
2. Ballard, W. W., and Simpson, D. M. Behavior of cotton planted at different dates in weevil control experiments in Texas and South Carolina. U. S. D. A., Bul. 1320, 1925.
3. Barrs, J. E. Marketing cotton seed for planting purposes. U. S. D. A., Bul. 1056, 1922.
4. Brown, J. B., and Gibson, Frederick. A machine for treating cotton seed with sulphuric acid. Arizona Agr. Exp. Sta., Bul. 105, 1925.
5. Brown, H. B. Cotton experiments in 1918. Mississippi Agr. Exp. Sta., Bul. 186, 1919.
6. Brown, H. B. Cotton spacing. Mississippi Agr. Exp. Sta., Bul. 212, 1923.
7. Cardon, P. V. Experiments with single-stalk cotton culture in Louisiana, Arkansas, and North Carolina. U. S. D. A., Bul. 526, 1918.
8. Cates, H. R. Farm practice in the cultivation of cotton. U. S. D. A., Bul. 511, 1917.

9. Churchill, O. O., and Wright, A. H. Cotton culture. Oklahoma Agr. Exp. Sta., Bul. 97, 1912.
10. Cook, O. F. A new method of cotton culture and its application. U. S. D. A., Farmers' Bul. 601, 1914.
11. Cook, O. F. Single stalk cotton culture. U. S. D. A., Bur. of Plant Industry, 1130, 1914.
12. Ewing, E. C.; Ricks, J. R.; Ames, C. T.; and Walker, G. B. Cotton experiments, 1914. Mississippi Agr. Exp. Sta., Bul. 169, 1914.
13. Hall, E. E., and Armstrong, George M. Cotton experiments at Florence, S. C. South Carolina Agr. Exp. Sta., Bul. 225, 1926.
14. Johnson, Elmer, and Coad, B. R. Dusting machinery for cotton, boll weevil control. U. S. D. A., Farmers' Bul. 1098, 1920.
15. Jensen, W. C. Farm organization and cost of production on cotton farms in Anderson County. South Carolina Agr. Exp. Sta., Bul. 221, 1924.
16. Morehouse, L. A., and Cooper, M. R. Cost of producing cotton. U. S. D. A. Bul. 896, 1923.
17. McClelland, C. K. Cotton and corn. Georgia Agr. Exp. Sta., Bul. 128, 1919.
18. Perkins, W. R. Cotton, 1909. Mississippi Agr. Exp. Sta., Bul. 135, 1910.
19. Ricks, J. R. Cotton experiments, 1916. Mississippi Agr. Exp. Sta., Bul. 178, 1916.
20. Webber, Herbert J., and Boykin, E. B. The advantage of planting heavy cotton seed. U. S. D. A. Farmers' Bul. 285, 1907.
21. Williams, C. B.; Kilgore, B. W.; and Russell, A. R. Fertilizer experiments with cotton on Piedmont Cecil sandy loam soil, and varieties, culture and fertilization of cotton on Piedmont Cecil sandy loam and red clay soils. North Carolina Agr. Exp. Sta., Bul. 227, 1914.

CHAPTER IX

FERTILIZERS FOR COTTON

Under conditions which have existed for the last half century, fertilizers have played an important part in the development of profitable agriculture in the South. They are destined to play an even more important part in the future, especially in the western half of the Cotton Belt.

The Need for Lime. — Only in a very few cases can the application of lime be recommended for cotton. Most of the experiment stations have found the application of lime to give negative results. However, the application of lime to the soil may be indirectly of value to cotton where it is applied to lime-loving legumes and these legumes turned under, thus increasing the total amount of nitrogen and organic matter available for the following crop of cotton.

The Alabama Station has reported a seven-year average yield of cotton grown in a three-year rotation where lime had been applied at the rate of 2 tons per acre at the beginning of the rotation. The results are given in the following table:

THE EFFECT OF LIME ON THE YIELDS OF COTTON GROWN IN A THREE-YEAR ROTATION

Plat No.	Fertilizers Pounds per Acre	Cropping System	Seven-year Average Yield Seed-cotton
1, 5 9, 13	None	3-yr. rotation peas and clover for soil improvement	425
6	Acid phosphate, 240 Cotton-seed meal, 200 Kainit, 200	3-yr. rotation peas and clover for soil improvement	619
10	Acid phosphate, 240 Cotton-seed meal, 200 Kainit, 200 Lime, 2 tons	3-yr. rotation peas and clover for soil improvement	781

The Need of Nitrogen, Phosphorus, and Potassium. — As has already been pointed out in other chapters, of the ten essential elements of plant food required by all plants, only three generally need to be applied to make up the deficiency which exists in the soil. These three elements are nitrogen, phosphorus, and potassium. Nitrogen is the first limiting element in most of the soils of the Cotton Belt, being followed by



FIG. 36. — A well fertilized field of cotton. (Photograph by J. Horace McFarlane Company, Harrisburg, Pa.)

phosphorus as a close second, and by potassium as a slow third. Soils containing a high percentage of organic matter, such as bottom lands and some of the soils of the Black Prairie, do not require the addition of nitrogen. In fact, the nitrogen content of some of these soils is so high that cotton plants readily go to weed, and as a result the yield is reduced. However, these soils make up only a small area as compared with the total area of the Cotton Belt. Very few soils are so rich that phosphorus may be left out of the fertilizer, and yet we do have examples

of such soils. There are more soils of this class west of the Mississippi River than east of it. Where the organic matter is maintained on fertile clay soils, potassium may be partly done away with. However, the application of potassium to sandy soils, particularly those of our coastal plain, and to clay soils of a run-down nature, will always have to be made to a greater or less extent.

Value of Farmyard Manure as a Fertilizer. — The value of manure, as the science of soil fertility has shown us, is due, outside of the biological effects it has when mixed with the soil, to the amount of organic matter, nitrogen, phosphorus, and potassium which it contains. According to Hopkins, 10 pounds of nitrogen, 3 pounds of phosphorus, and 8 pounds of potassium may be used as a working basis for the average composition of a ton of barnyard manure. If we assign the value of 22 cents a pound for nitrogen, 8 cents a pound for soluble phosphorus, and 3 cents a pound for potassium, a ton of average manure has a commercial value of \$2.68 because of the fertilizer elements that it contains. As the value of these elements changes from year to year, of course, the value of a ton of average manure changes also. The agricultural value of manure varies on different types of soil and from year to year and can be determined only by the farmer himself. From six to twelve tons of manure broadcasted per acre is usually recommended for cotton. It should be remembered that barnyard manure is a very unbalanced fertilizer, and that the bad results sometimes secured with cotton when large quantities of manure are used are due to this unbalanced condition. It is well to reinforce the manure with some kind of phosphatic fertilizer in order to balance the excessive amount of nitrogen which manure contains.

Nitrogenous Fertilizers. — The nitrogenous fertilizers, or those fertilizers that carry the element nitrogen, — commonly referred to as ammonia, — may be divided into two groups. First, there are those fertilizers which carry of the three plant food elements (nitrogen, phosphorus, and potassium) only nitrogen, — such as sodium nitrate, ammonium sulphate, calcium cyanamid, urea, ammonium nitrate, and calcium nitrate. Second, those fertilizers which contain not only nitrogen, but also phosphorus or potassium, or both, — such as cottonseed meal, dried blood, tankage, fish scrap, ground raw bone, and ground steamed bone.

The sources of these materials are very varied. Sodium nitrate, or "soda" as it is called by the cotton farmer, is a mined product coming from Chili and Peru. The beds from which this material is secured have supplied the world for the last eighty years, and may continue to do so for years to come. However, the supply is not inexhaustible, and the world has already begun to turn to other forms of nitrogen carriers

since there are no other deposits of sodium nitrate of any size known to exist in any other part of the world. Ammonium sulphate is a by-product of the destructive distillation of coal, and the world's annual output is on the increase. Calcium cyanamid, urea, ammonium nitrate, and calcium nitrate are the products of the rather recently discovered methods of chemical and electrical fixation of nitrogen from the air. It was upon such materials largely that Germany depended for the nitrogen incorporated in her explosives during the World War, as she was cut off from the sodium nitrate deposits of Chili.



FIG. 37. — Hand method of applying fertilizer. (Courtesy, The National Fertilizer Association.)

Cottonseed meal is a by-product of the cottonseed oil industry. It consists of the remains of the cotton embryos after they have been pressed and the oil removed. The oil which is removed is of no value as a fertilizer, as it contains neither nitrogen, phosphorus, nor potassium, and since it has a commercial value from other standpoints it should be removed. Because of the value of cottonseed meal as a feed its price has risen in the last few years to such a point that its use as a fertilizer is becoming prohibitive.

Dried blood and tankage are the by-products of the meat packing industry. Dried blood, as the name indicates, is made up principally of dried blood. Tankage is a slaughter-house by-product and consists of the ground remains of all portions of animals that could not be used for other purposes. Fish scrap may be either the ground unusable

portions of fish, or it may consist of the entire fish, ground usually after the oil is extracted.

Ground raw bone and ground steamed bone are also by-products of the meat packing industry. The steamed ground bone differs from the raw ground bone in that the former has been heated in order to remove the oil, and in this process some of the nitrogen is driven off, thus reducing the nitrogen content of the material.

The most commonly used classification of the nitrogenous fertilizers divides them into organic and inorganic fertilizers. The organic fertilizers are those that are derived from organic sources, as for example, cottonseed meal, dried blood, and tankage. The inorganic fertilizers are those that have been secured from inorganic sources, as for example, nitrate of soda, ammonium sulfate, and calcium nitrate. The organic fertilizers may have a feeding as well as a fertilizing value. For this reason a pound of nitrogen in the form of an inorganic fertilizer is much cheaper than a pound of nitrogen bought in the organic form. Some of the southern agricultural experiment stations are already advocating that, except in very sandy soils, only one-third of the nitrogen of cotton fertilizers be applied in the organic form. The time may come when even this percentage will become prohibitive and practically all nitrogenous fertilizers will be applied in the inorganic form.

Phosphatic Fertilizers. — The phosphatic fertilizers, or those fertilizers which carry phosphorus, — commonly referred to as phosphoric acid, — consist principally of raw, acid, and Thomas phosphate, and acidulated bone, although cottonseed meal, tankage, fish scrap, and blood contain varying amounts. Raw rock phosphate is the mineral apatite which has been ground. This material is mined principally in Tennessee, Florida, and South Carolina. Large deposits of apatite are known to exist in other parts of the country. When about equal parts of sulphuric acid and raw rock phosphate are mixed, a product is secured which is known as acid phosphate, or “acid,” as it is called by the cotton farmer. This differs from the raw rock phosphate in that the phosphorus which it contains can more readily be used by the plant than the phosphorus of the rock phosphate. Since the mixing of the raw rock and the sulphuric acid is in proportion of about one to one, for every ton of raw rock phosphate used two tons of acid phosphate are produced, and the total number of pounds of phosphorus in a ton is only one-half as much as in rock phosphate. When larger proportions of sulphuric acid to rock phosphate are used a product known as double-super phosphate is produced. This product contains an even higher percentage of phosphorus than acid phosphate. Thomas phosphate or basic slag is a by-product of the iron smelting industry. It is a basic compound

produced through the uniting of lime with the phosphatic impurities found in the iron ore. The phosphorus in acidulated bone is of the same composition as the phosphorus in acid phosphate, for the phosphorus in raw bone is of the same composition as the phosphorus in raw rock phosphate, and the acidulated bone has been made by the addition of sulphuric acid to the bone, just as sulphuric acid is added to raw rock phosphate to make acid phosphate.



FIG. 38. — Filling the hopper of a fertilizer distributor. (Courtesy, The National Fertilizer Association.)

Potassic Fertilizers. — The commercial fertilizers containing potassium — commonly referred to as potash — which are most commonly used under cotton are kainit, muriate of potash, manure salts and sulphate of potash. In the past most of this material came from the potash mines of Germany. During and immediately after the World War, the German supply being cut off, small quantities of these materials were produced in this country. The value of wood ash as a carrier of potassium should not be overlooked, for it carries just half as much as kainit, and also some phosphorus and calcium. About 50 per cent of wood ash is made up of lime. After six years of experimentation the South Carolina Agricultural Experiment Station reported that kainit and muriate of potash were of equal value for the production of cotton when applied at the same rate of potash per acre.

Composition of Common Materials used in Cotton Fertilizers. — The following table shows the average amount of nitrogen, phos-

phorus, and potassium usually found in our most common fertilizers. The quantity of nitrogen, phosphorus, and potassium is given instead of ammonia, phosphoric acid, and potash because the author considers it a more simple means of expressing the plant food elements. However, the number of pounds of ammonia in a ton of any fertilizer may be secured by multiplying the number of pounds of the nitrogen by the factor 1.214, the number of pounds of phosphoric acid by multiplying the number of pounds of phosphorus by the factor 2.274, and the number of pounds of potash by multiplying the number of pounds of potassium by the factor 1.205.

	Nitrogen	Phosphorus	Potassium
Sodium nitrate.....	310		
Ammonium sulphate.....	400		
Urea.....	940		
Dried blood.....	280		
Cottonseed meal.....	136	27	30
Calcium cyanamid.....	400		
Calcium nitrate.....	240		
Raw bone meal.....	80	180	
Steamed bone meal.....	20	250	
Acidulated bone meal.....	40	140	
Acid phosphate.....		125	
Raw rock phosphate.....		250	
Double super-phosphate.....		400	
Thomas phosphate (basic slag)...		160	
Kainit.....			200
Wood ash.....		10	100
Potassium chloride.....			850
Potassium sulphate.....			850
Manure salts.....			330

The above mentioned fertilizers may be bought separately or as mixed goods. More mixed goods are sold to farmers than are separate materials. The mixed goods are put upon the market as certain brands, or under certain trade names. In the past farmers have judged the value of the fertilizer too much by its name rather than by its content. The law requires that the composition also be stated on the tag. The composition in percentage of ammonia, but sometimes nitrogen, of phosphoric acid, and of potash is usually given on the tag. For instance, an 8-3-3 formula means that there is 8 per cent of phosphoric acid, 3 per cent of ammonia, and 3 per cent of potash. In some states the formula

may read 3-8-3, 3 per cent nitrogen, 8 per cent phosphoric acid, and 3 per cent potash. The percentage of phosphoric acid refers to available phosphoric acid. If there is unavailable phosphoric acid present also, it is sometimes designated. Other figures referring to the composition of the fertilizer may be found on the tag, but these are often more confusing than otherwise to the average farmer. The composition as found on the fertilizer tag would be simplified, and far more understandable to the farmer, if only the percentage of ammonia in the form of organic and inorganic materials, the percentage of citric acid soluble phosphoric acid, and the percentage of water soluble potash were given. If the nitrogen is recorded in the form of ammonia, the number of pounds of nitrogen per ton can be determined by multiplying the number of pounds of ammonia per ton by the factor .8235; if the phosphorus is recorded as phosphoric acid the number of pounds of phosphorus can be determined by multiplying the number of pounds of phosphoric acid in a ton by the factor .4366; and if the potassium is recorded as potash the number of pounds of potassium can be determined by multiplying the number of pounds of potash per ton by the factor .829.



FIG. 39. — "All set" to distribute the fertilizer. (Courtesy, The National Fertilizer Association.)

Loss of Plant Food Elements from the Soil. — It should be the plan of every cotton grower to increase, or balance, the fertility of his soil so that a maximum crop of cotton can be produced in the average years, and then to maintain that fertility. In order to maintain the fertility of the soil intelligently he should have some idea of how much plant food is removed in a maximum crop, and how much is removed by erosion and leaching. There are no authoritative data available showing the

average quantity of nitrogen, phosphorus, and potassium removed from the various Cotton Belt soils through leaching and washing during the year. Nevertheless, it is probable that as much plant nutrients is removed every year through washing and leaching as is removed in the crops that we grow. The following table shows, according to Hopkins,¹ the composition of a crop of cotton lint, seeds, and stalks:

	Nitrogen	Phosphorus	Potassium
Cotton lint (1000 lbs.).....	3	.4	4
Cottonseed (2000 lbs.).....	63	11.0	19
Cotton stalks (4000 lbs.).....	102	18.0	59
	168	29.4	82

At the prices for nitrogen, phosphorus, and potassium already cited, a two-bale crop of cotton, if everything is removed, would take from the soil \$41.77 worth of plant food elements. However, the stalks should be turned under, and enough cottonseed meal, or its equivalent of fertilizer, applied containing the same amounts of nitrogen, phosphorus, and potassium as is found in the cotton seed. The amount of plant food elements removed by the lint is negligible, its value amounting to only \$.81. The Cotton Belt farmer has a great advantage over the Corn Belt farmer in that the maximum yield (2 bales of lint) of his cash crop removes only 3 pounds of nitrogen, .4 pounds of phosphorus, and 4 pounds of potassium, whereas the Corn Belt farmer's cash crop, corn (100 bushels of grain), will remove 100 pounds of nitrogen, 17 pounds of phosphorus, and 19 pounds of potassium. The total value of the three plant food elements, nitrogen, phosphorus, and potassium, removed in the grain amounts to \$23.93.

The composition of the plant, just as the composition of the soil, cannot serve as an infallible guidepost whereby the fertilizing of the soil can be directed, yet it may act as a pointer which should influence us in our fertilizing.

How to Determine which Element is the Limiting Factor. —There are a number of ways in which a farmer may determine what kind and amount of fertilizer his crop needs. First, by learning something of the physical and chemical composition of the soil, — information regarding which may usually be supplied by the agricultural colleges or the United States Department of Agriculture. Sandy soils are usually lacking in

¹ Hopkins C. G.; Soil Fertility and Permanent Agriculture; Ginn & Co., Boston.

potassium, while clay soils are rich in that element. Swampy soils, or soils rich in organic matter, are rich in nitrogen, while soils devoid of organic matter contain very little nitrogen. Second, by noting the condition and method of growth of crops. Plants that are small in stature and of a light green color usually lack nitrogen. Cotton plants which are extremely affected by rust usually lack potassium. Third, by running a fertilizer test. A good plan for doing this is to select an acre which is uniform and level, but well drained, and divide it into nine parts or plots. Number the plots consecutively from one to nine. Plow and prepare, plant and cultivate the acre just as you would any other acre on your farm, but apply the different fertilizer combinations given below to each of the nine plots as follows:

- Plot 1. .nothing

Plot 2. .nitrogen

Plot 3. .phosphorus

Plot 4. .potassium

Plot 5. .nitrogen, phosphorus
- Plot 6. .nitrogen, potassium

Plot 7. .phosphorus, potassium

Plot 8. .nitrogen, phosphorus, potassium

Plot 9. .nothing

The quantity of each element applied should be the same as that incorporated in the mixed fertilizers most commonly used in the community. Other plots may be made and a comparison of different applications and of the different carriers of the elements may be made if so desired. It is needless to say that the crop from each plot must be harvested separately, and the yields compared.

This method of experimenting should extend over a period of years in order to make sure that all inequalities in climatic conditions which would affect the yield are reduced to a minimum through the process of averaging. Results somewhat similar to those shown in the following table should be secured.

THE EFFECT ON YIELD OF FERTILIZING COTTON WITH AN UNBALANCED FERTILIZER.
AVERAGE RESULTS FROM SOUTH CAROLINA COÖPERATIVE FERTILIZER
EXPERIMENTS, 1920-1923

Treatment	Element lacking in fertilizer	Yield seed cotton	Decrease in yield due to need for other element
P., N. and K.....	None	1084	...
P. and N.....	K.	1009	75
N. and K.....	P.	884	200
P. and K.....	N.	670	414
None.....	All	495	589

The Effect of Nitrogen, Phosphorus, and Potassium on the Growth of the Cotton Plant. — The apparent influence of nitrogen, phosphorus, and potassium upon the cotton plant should be known by the farmer. Nitrogen produces a dark green luxuriant color in the foliage. When it is applied in small quantities it helps to produce normal growth, and hastens maturity; but when applied in large quantities an excessive vegetative growth is produced and maturity is delayed. Phosphorus hastens maturity and may also aid in root development. Potassium may also hasten maturity. This element causes the leaves to stay on the plant longer in the fall, and under some conditions prevents the black rust from overcoming the plants. The following table shows the influence on earliness of cotton when complete fertilizers carrying varying proportions of ammonia, phosphoric acid, and potash were applied. Results secured by the South Carolina Station:

THE EFFECT ON EARLINESS OF COTTON OF VARYING THE PERCENTAGE OF AMMONIA PHOSPHORIC ACID, AND POTASH IN A COMPLETE FERTILIZER. FIGURES ARE PERCENTAGES OF TOTAL YIELDS OBTAINED AT FIRST PICKING

Element	No. of experiments averaged	No. of soil types represented	No. of years averaged	Lbs. of complete fertilizer applied	0%	1%
NH ₃	7	7	16	600-1000	47.9	....
P ₂ O ₅	7	7	16	600-1000	47.1	....
K ₂ O.....	5	5	12	600-800	54.4	54.3

Element	2%	3%	4%	5%	6%	8%	10%	12%
NH ₃	53.1	53.5*	57.6	50.3†	52.6	52.5	46.1‡	....
P ₂ O ₅	53.5*	....	50.9	....	57.0	57.1	57.7	48.7§
K ₂ O.....	52.6	42.1	50.0	....	....	....	....	....

* 6 experiments averaged.

† 4 experiments averaged.

‡ 5 experiments averaged.

§ 3 experiments averaged.

Value of Fertilizers. — The value of applying fertilizers may be summed up as follows: (1) it increases the yield, (2) when judiciously used it hastens the maturity. When fertilizers are applied to soils of

good physical condition they yield a higher return than when applied to soils of poor physical condition.

The following table taken from South Carolina Station Bulletin 219 shows the influence of fertilizers on the hastening of maturity of cotton that was grown on four soils of the Piedmont Soil Province and three soils of the Coastal Plain Soil Province.

THE EFFECT OF VARYING THE AMOUNT OF A COMPLETE FERTILIZER ON EARLINESS OF COTTON. FIGURES ARE PERCENTAGES OF TOTAL YIELDS OBTAINED AT FIRST PICKING

Soil Province	No. of soil types represented	No. of years averaged	Pounds of fertilizer applied per acre		
			None	200	400
Piedmont.....	4	11	34.1	48.8	51.7
Coastal Plain..	3	16	41.9	48.5	58.0

Soil Province	Pounds of fertilizer applied per acre					
	600	800	1000	1200	1400	1600
Piedmont.....	52.9	54.5	50.2	50.9	49.0	44.5
Coastal Plain.....	55.4	59.6	56.2	55.9	52.2	52.3

Use of Nitrogenous Fertilizers. — Nitrate of soda and ammonium sulphate are now the most commonly used nitrogenous fertilizers. Readily available forms of nitrogen such as these should not be applied very long before the planting of cotton. When second applications of nitrogen are made after the cotton is up, nitrate of soda is most commonly used. Because of the influence of readily available nitrogenous fertilizers on the vegetative growth of the cotton plant, the best time to apply the fertilizer has been changed in recent years by the advent of the boll weevil. Before the coming of the boll weevil the best time to apply “soda” proved to be about six to eight weeks after planting, but since the arrival of the boll weevil the best time seems to be either before or by the time the first squares appear. In April, 1920, the Alabama Station reported the results of fourteen experiments on the time of

applying nitrate of soda to cotton. These experiments were conducted in many parts of the state of Alabama during the years 1914–1919, and under boll weevil conditions. The results of these experiments indicated: (1) that nitrate of soda at the rate of 100 pounds per acre gave best results when applied by, or before, the time the first squares appeared; (2) that 200 pounds of nitrate of soda per acre, when used in



FIG. 40. — The plot on the right received no fertilizer. The plot on the left received 600 pounds of a 10–4–2. (Courtesy, South Carolina Experiment Station.)

two applications (100 pounds when “dirted” and 100 pounds about three weeks after the first blooms appeared), was more effective and slightly more profitable than was only 100 pounds of nitrate of soda; (3) that 100 pounds of nitrate of soda per acre, applied when the plants were first “dirted,” was more effective than was 200 pounds of cottonseed meal applied at the same date, each being followed with a later application of 100 pounds of nitrate of soda.

The amount of nitrate of soda to apply will depend upon local economic conditions such as the cost of the fertilizer, the probable price the cotton will bring, etc. This is shown in the following table by the yield secured in a one-year test at Clemson College, South Carolina, in which 600 pounds of an 8–5–2 was applied before planting and varying amounts of the top-dresser applied just after chopping.

RESULTS OF RATE OF APPLICATION OF SODA TEST, CLEMSON COLLEGE, S. C., 1923

Rate soda applied	Yield first picking	Total yield
Check — No. top-dresser.....	218	998
50 lbs. soda per acre.....	230	1126
100 lbs. soda per acre.....	230	1161
150 lbs. soda per acre.....	218	1162
200 lbs. soda per acre.....	193	1222
250 lbs. soda per acre.....	254	1307
300 lbs. soda per acre.....	278	1367

The greatest increase in yield per pound of fertilizer used appears in the lower applications.

The nitrogen in cottonseed meal, dried blood, tankage, and fish scrap becomes available more slowly than the nitrogen of nitrate of soda or ammonium sulphate, but this is often desired in order that normal growth may take place. Nitrogen in organic fertilizers always costs more than nitrogen in inorganic fertilizers. It has been found that one pound of nitrogen is not of the same value to the plant when applied in different fertilizers. Following are the results of a four-year test conducted at the Georgia Experiment Station with the comparison of equal quantities of nitrogen in the form of cottonseed meal, sodium nitrate, and ammonium sulphate.

COMPARATIVE VALUE OF NITROGEN IN COTTONSEED MEAL, SODIUM NITRATE AND AMMONIUM SULPHATE

Nitrogen carrier	Yields seed cotton per acre				
	1909	1910	1911	1912	Average
Cottonseed meal.....	1380	1246	1334	1277	1309
Sodium nitrate.....	1427	1269	1357	1257	1327
Ammonium sulphate.....	1502	1297	1416	1277	1372
Check.....	889	963	940	....	....

The Mississippi Station also conducted an experiment during 1921 and 1922 to determine the relative value of common nitrogen carriers. The



FIG. 41. — The plot on the right received no fertilizer. The plot on the left received a complete fertilizer. (Courtesy, South Carolina Experiment Station.)

fertilizer was applied at the rate of 15 pounds of available nitrogen per acre. The results of two years are given in the following table:

RELATIVE VALUE OF SOME COMMON NITROGENOUS FERTILIZERS FOR COTTON

Fertilizer	Pounds lint per acre		
	Total	1921 Increase	1922 Increase
Ammonium sulphate.....	416.1	51.5	91.2
Nitrate of soda.....	412.8	62.3	88.0
Calcium cyanamid.....	388.4	57.8	63.6
Cottonseed meal.....	371.1	1.6	46.2
None.....	324.1	....	....

The relative value of the various nitrogenous fertilizers as top-dressers is shown in the results given below of a test conducted by the South Carolina Station during the years 1919 to 1923. Six hundred pounds

of an 8-3-2 was used at planting time and an equivalent of 18 pounds of ammonia was used as a side-dresser.

RESULTS FROM SOURCE OF AMMONIA TOP-DRESSING TEST, CLEMSON COLLEGE, S. C., 1919-1923

Source of ammonia	Yield seed cotton per acre					4-yr. average	5-yr. average
	1919	1920	1921	1922	1923		
Check — No top-dresser ...	740	...	...	1122	1196	....	....
Nitrate of soda.....	790	796	890	1609	1342	1159	1085
Sulphate of ammonia.....	...	746	930	1552	1355	1146	....
Cyanamid.....	545	826	802	1258	1149	1009	916
Nitrate of lime.....	...	...	...	1404	1335	....	....
Ammonium Nitrate.....	930	714	866	1507	1322	1102	1068

Use of Phosphatic Fertilizers. — Phosphorus for cotton is used almost universally as acid phosphate. It nearly always is applied in the furrow before planting. Experimental evidence has indicated that it may be found by further investigation that side applications are more efficient in hastening maturity.

Use of Potassic Fertilizers. — Potassium is used almost entirely as muriate of potash, manure salts, sulphate of potash, and kainit. It is well to note that in most of the experiments that have been conducted for the prevention of rust kainit has been used. Below are the results of a four years' comparison by the Georgia Station of muriate of potash and kainit as carriers of potassium.

COMPARATIVE VALUE OF POTASSIUM IN MURIATE OF POTASH AND KAINIT

Potassium carrier	1909	1910	1911	1912	Aver- age
Muriate of potash.....	1293	1671	1803	1018	1446
Kainit.....	1420	1603	1806	1064	1473

After six years of experimentation the South Carolina Station reported in Bulletin 209 that kainit and muriate of potash were of equal

value for the production of cotton when applied at the same rate of potash per acre.

Home Mixing of Fertilizers. — The process of home mixing of fertilizers should be known by every cotton farmer, for while in some years the product can be secured more cheaply as ready-mixed fertilizer than it can be mixed at home, yet in other years the individual ingredients may be had at such prices that 20 to 30 per cent may be saved by home mixing. Factory-mixed fertilizers are of no more value than home-mixed fertilizers. While it is true that the factory-mixed material



FIG. 42. — Fertilizer test plots in the Sand Hill region of South Carolina. On the left no fertilizer; on the right 1000 pounds of 8-4-4. Lime was applied on the distant end of both plots. (Courtesy, South Carolina Experiment Station.)

is more thoroughly mixed, yet the difference, when compared as to the effects upon yield, is nil. All that is needed for home-mixing is a smooth floor upon which to mix the fertilizers, and shovels sufficient for the hands doing the mixing. By figuring the number of pounds of ammonia, phosphoric acid, and potash desired per acre, and referring to the number of pounds of these ingredients in the fertilizers to be used in the mixture, it is easy to figure the amount of each material to be used. Mixing of fertilizers should be done in the winter months when there is no rush work to be done on the farm. One great advantage of home-mixing, outside of the financial saving in cost of the separate ingredients is the elimination of the expense of hauling and spreading the rather useless material found in many commercial fertilizers and especially in those of low analysis, called filler. This material is usually

made up of some inert substance of no value as plant food, which has been added during the mixing of the fertilizer, in order to bring the total weight up to a ton. In most communities farmers may make a further saving by practicing coöperation and buying in carload lots. The present tendency is toward the elimination of low grade fertilizers from the market as high grade fertilizers always give the greatest return on the money invested.

It is well to keep in mind that there are some fertilizers that should not be mixed, due either to their effect upon the availability of each other, or upon the mechanical consistency of the mass. The following table taken from Van Slyke, L. L., "Fertilizers and Crops," Orange Judd Publishing Company, pp. 485-486, illustrates the kind of fertilizers that should not be mixed.

"calcium oxide calcium hydrate wood ashes basic slag calcium cyanamid basic calcium nitrate	} } } } } } }	should not be mixed with	{ ammonium sulfate { animal manures { as tankage, { blood and the { like, { nitrogenous { guanos
"calcium oxide calcium hydrate calcium carbonate wood ashes basic calcium nitrates	} } } } } }	should not be mixed with	{ soluble phos- { phates of any { kind
"calcium oxide calcium hydrate basic calcium nitrate	} } } }	should not be mixed with (un- less applied immedi- ately)	{ sodium nitrate { potassium chloride { kainit, and the { like"

The Relation of Legumes to the Maintenance of Nitrogen. — It should be the object of every cotton farmer to maintain the nitrogen of his soil through the use of legumes. Leguminous crops have the power to extract nitrogen from the air indirectly, so that when they are turned under this nitrogen is incorporated in the soil. For every ton of legume hay that is turned under, nitrogen equivalent to that in four tons of manure is added to the soil. The influence of leguminous cover crops, when used as green manuring crops, upon succeeding crops of cotton is clearly brought out in the following table, taken from Circular No. 48, of the Alabama Agricultural Experiment Station:

THE EFFECT OF LEGUMES TURNED UNDER ON THE YIELDS OF COTTON

Plot	Fertilizer	Appli- cation pounds per acre	Cropping system	Average yield pounds seed cotton		
				1st ten years	2nd ten years	3rd ten years
6	Acid phos- phate kainit	160	Cotton con- tinuously no legumes	803	573	360
		160				
3, 8	Acid phos- phate kainit	160	Cotton con- tinuously vetch as cover crop	813	678	602
		160				
5, 9	Acid phos- phate kainit	160	Cotton and vetch cowpeas	890	958	1042
		160				



FIG. 43. — Comparing the first picking from plots receiving different fertilizer treatment. (Courtesy, U. S. Dept. of Agriculture.)

Professor Funchess, in commenting upon these results, says:

“Special attention should be called to the fact that the vetch crops grown on the plots have never been very satisfactory, but the poor growth is now known to be due to the lack of available phosphorus in the soil. Had these plots been well fertilized with phosphatic fertilizers, instead of only 160 pounds per acre each year, doubtless the results would have been more striking.”

In another group of experiments conducted by the Alabama Station, which has been in operation for only one rotation cycle, the use of cow-peas and crimson clover wherever possible within the 3-year rotation — cotton, oats and corn — has more than doubled the yield of seed-cotton. The results are given below:

THE EFFECT OF LEGUMES TURNED UNDER, ON THE YIELDS OF COTTON GROWN IN A THREE-YEAR ROTATION

Plot	Fertilizers lbs. per acre	Cropping system	Av. yield of seed cotton (3 years)
A	Acid phosphate, 240 kainit, 200	Three-year rotation, peas and clover for soil improvement	531
B	Acid phosphate, 240 kainit, 200	Three-year rotation, no peas or clover	227
C	None	Three-year rotation, no peas or clover	142

Do Cotton Fertilizers Pay? — Because of the increased yield and early maturity produced by the use of fertilizers, the area in the United States in which cotton can be grown successfully has been pushed farther north and west. Fertilizers, as they are used today on cotton, pay and pay well. The average yield of cotton in the states of the eastern Cotton Belt was raised through the use of commercial fertilizers for the first fifteen years following 1892 to more than offset the loss resulting from the boll weevil in the western half. A given amount of plant food converted into cotton is worth two to three times as much as if converted into corn and oats. Yet, this increase can, and should, be enlarged further through the more judicious methods of using fertilizer. The average land in the South, without fertilizers, produces very

little cotton; in fact, in many cases not enough to pay for the cost of raising the crop.

The Application of Cotton Fertilizers. — Fertilizers were first used on cotton about 1860. There was an idea prevalent at that time that the use of fertilizers would finally decrease the yield. Of course, where only small applications of fertilizer are made, and large crops are removed, the soil does become poorer, for a larger amount of the plant food elements is removed from the land than is applied in the fertilizer.

Not all the fertilizer used on the cotton plantation is "put to" cotton, but it is nearly always paid for out of the proceeds of the cotton crop.

The oldest cotton fertilizer experiment in the South in existence today was started in 1889, and is situated at Calhoun, Louisiana.

Fertilizers are usually drilled, rather than broadcasted, in the Cotton Belt, because in this way the plants are able to utilize the fertilizer to better advantage. However, when extra heavy applications of fertilizer are made, broadcasting should be the rule. The fertilizer is usually drilled about three to four inches below the surface of the soil, either by hand or by fertilizer distributors. The mixtures most commonly used throughout the South contain two to three times as much phosphoric acid as nitrogen or potash. The most popular mixed goods is a 10-4-3, or 10 per cent phosphoric acid, 4 per cent ammonia, and 3 per cent potash. It should be kept in mind that the richer the fertilizer, the cheaper relatively it is in the long run, because the farmer does not have to pay for mixing, sacking, hauling, and freight on large quantities of filler. From 200 to 2000 pounds of fertilizer are applied per acre. On the average land 400 to 600 pounds are used. More money is returned when large applications are made, but a higher percentage where the medium applications are made. Below is given the profit secured from the use of different quantities of fertilizer per acre in 1913 and in 1919 at the North Carolina Station.

Amount of complete fertilizer per acre, pounds	Value of increase per acre above cost of fertilizer	
	In 1913	In 1919
200	\$16.12	\$37.97
400	19.57	46.11
600	25.50	50.06
800	22.01	51.85
1200	22.04	51.95

REFERENCES

1. Blackwell, C. P., and Collings, G. H. Trona Potash — A progress report. South Carolina Agr. Exp. Sta., Bul. 202, 1920.
2. Blackwell, C. P., and Buie, T. S. Fertilizer Experiments. South Carolina Agr. Experiment Sta., Bul. 209, 1921.
3. Blackwell, C. P. Fertilizer experiments with cotton. South Carolina Agr. Exp. Sta., Bul. 211, 1922.
4. Blackwell, C. P., and Buie, T. S. Cotton production. South Carolina Agr. Exp. Sta., Bul. 219, 1924.
5. Brown, H. B. Cotton experiments in 1915. Mississippi Agr. Exp. Sta., Bul. 173, 1916.
6. Duggar, J. F. Local fertilizer experiments with cotton in North Alabama in 1911. Alabama Agr. Exp. Sta., Bul. 162, 1911.
7. Duggar, J. F.; Williamson, J. T.; and Hawley, L. J. Local fertilizer experiments with cotton in North Alabama in 1913. Alabama Agr. Exp. Sta., Bul. 175, 1914.
8. Fraps, C. S. Coöperative fertilizer experiments with cotton, corn, sweet potatoes, and Irish potatoes, 1908-17. Texas Agr. Exp. Sta., Bul. 235, 1918.
9. Funchess, N. J. Legumes in relation to soil fertility. Alabama Agr. Exp. Sta., Cir. 48, 1923.
10. Harper, J. N. Fertilizer experiments with cotton. South Carolina Agr. Exp. Sta., Bul. 145, 1909.
11. Kimbrough, J. M. Cotton culture. Georgia Agr. Exp. Sta., Bul. 100, 1912.
12. Kimbrough, J. M., and DeLoach, R. J. H. On cotton cultivation. Georgia Agr. Exp. Sta., Bul. 105, 1914.
13. Ricks, J. R., and Ewing, E. C. Cotton experiments in 1912. Mississippi Agr. Exp. Sta., Bul. 161, 1912.
14. Van Slyke, L. L. Fertilizers and Crops. Orange Judd Company, pp. 485-486, 1912.
15. Whitney, Milton. Fertilizers for cotton soils. U. S. D. A., Bur. of Soils, Bul. 62, 1909.

CHAPTER X

DISEASES OF THE COTTON PLANT

The annual loss sustained by the farmers of this country from plant diseases is enormous, but the work of the U. S. Department of Agriculture, together with the work of the state agricultural experiment stations and colleges, is aiding materially in decreasing this yearly loss. Still much work remains to be done, not only in enlightening the farmer as to the facts already known concerning these diseases, but also in research leading to a broader knowledge and understanding underlying the individual diseases themselves. The loss to cotton alone for 1917 — which was a representative year — from diseases has been estimated to be something like 2,000,000 bales, as compared with about 11,000,000 bales which were produced that year.

Most of the damage done by diseases to cotton is wrought east of the Mississippi River. It is thought that the greater rainfall, together with the low altitude, explains, to some extent at least, this condition. Excessive rainfall and humid conditions favor very materially the development of rots. Likewise, the type of soil is linked more or less with the destructiveness of certain diseases.

While there is a large number of diseases of the cotton plant, the following are the most important:

Cotton Wilt (*Fusarium vasinfectum* Atk.). — This disease is a very destructive disease of the cotton plant, causing a greater annual loss than any other disease. It is found in every part of the Cotton Belt, but particularly on sandy soils in the states of South Carolina, Georgia, and Alabama. The disease is also known in other countries. It was first described in the early literature as “Frenching.” It is also known as “blight,” “black heart,” and “black rot.” The same disease attacks okra, and a similar wilt attacks watermelons, tomatoes, and cowpeas.

The cotton wilt fungus is both a saprophyte and a parasite. It is a fungous disease, and microscopic in size. It may live in the soil upon organic material, and as such is, of course, a saprophyte. Neither the type nor the physical state of the soil, nor natural physical forces, such as heat and cold acting upon the soil, seem to have much effect upon its vitality. It enters the plant through the roots and then changes

its mode of living and becomes a parasite. The action of this wilt is very similar in nature to the large number of other closely related wilts which attack a great variety of plants. Young plants more easily succumb to the attack than older ones. The greatest injury is supposedly due to the fact that the fungous body, or mycelium, fills the water passages which supply that part of the plant above ground. This results in the sapping of the vigor of the plant to a greater or less extent, the usual outcome being the rapid death of the plant.



FIG. 44. — A cotton plant infected with cotton wilt. 1, Plant; 2, cross sections of stem and root; 3, longitudinal sections of stem and root. (Courtesy, South Carolina Experiment Station.)

However, in some cases the plant may survive and send out a new growth. Occasionally plants will be found to resist the attacks of the wilt to a greater or less extent, and in such cases the farmer should take this opportunity to select and breed up wilt-resistant strains. The disease is readily spread through any agency that will carry and spread particles of the infected soils. Farm machinery which has been used on infected land and which has not been thoroughly cleaned is a source of common contamination. Once the soil has become contaminated with wilt, it will remain so for a number of years. The spots which

have become infected may even enlarge as the years go by. The fungus in the soil cannot be killed with fungicides. It is considered by most authorities that plants growing on sandy soils are more easily overcome by the wilt, but the damage is not confined to that type of soil. The disease usually starts in one section of the field, which then acts as a source of infection to the rest of the field. It has been suggested that infected seed may be a means of introducing the disease. Corn, the small grains, velvet beans, and some varieties of cowpeas have been found to be resistant to the wilt. The Dixie, Toole, Dillon, Lewis No. 63, Tri-Cook, Dixie-Cook, Dixie-Afifi, Dixie-Triumph, Covington, Sam Wood, Madella, Lightning Express, and Super Seven varieties of Upland cotton, and the Rivers variety of Sea Island cotton have been found to be resistant to this disease.



FIG. 45. — Dixie-Triumph hybrid cotton growing on wilt-infested land. (Courtesy, U. S. Dept. of Agriculture.)

The first attacks of the disease become noticeable in May or June when the plants have reached about five to ten inches in height. Some of the plants may die outright, others present a yellowish, unhealthy appearance. The leaves of some of the plants may show the first signs of attack by turning yellow around the edges, and particularly between the ribs. In some cases parts of the leaves may present a healthy appearance while other parts are already dead. The dead parts may become brittle and break off, leaving a ragged appearance to the leaf.

With the further progress of the disease the leaves fall from the plant and death soon takes place. Upon examination of the tap root by splitting it in two, a dark brown mass of dead vascular system is easily discernible.

One of the commonly proposed methods to prevent the disease is to rotate the crops, using such plants as are resistant to the disease. The best means of eradicating the disease is to keep cotton off of the field for a number of years, unless a wilt-resistant variety is used. The pulling up and burning of all infected plants will likewise aid in holding the disease in check. Egyptian cotton is more resistant to wilt than is the American Upland.

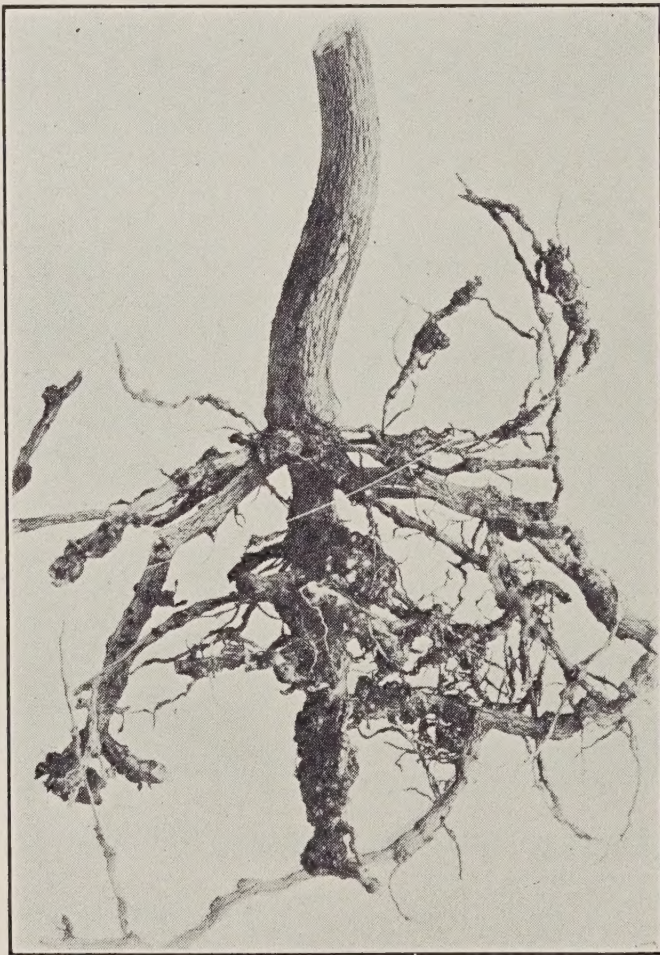


FIG. 46. — The root system of a cotton plant infected with cotton root knot. (Courtesy, U. S. Dept. of Agriculture.)

Gilbert, of the Bureau of Plant Industry, U. S. D. A., gives \$10,000,000 as the annual loss from this disease alone, in the United States.

Cotton Root Knot, or Root Gall (*Heterodera radicicola* Greef. Mul.) — Cotton root knot, or root gall, is found to the greatest extent

in the Coastal Plain soils. It is not very prevalent in the heavier clay types of the Piedmont Plateau. The disease is not specific to cotton alone, but it also attacks such other plants as tobacco, tomatoes, soybeans, cowpeas, watermelons, and even peach and pecan trees.

The disease is caused by tiny worms of microscopic size, known as eel worms, or nematodes. They range in size from about one-twentieth to one-sixtieth of an inch in length. The parasite enters the roots of the plant, becomes encysted in the tissue, and thus sets up an irritation. This irritation has some unknown effect upon the plant and causes it to produce corky, wart-like knots or growths at the point of irritation, varying in size from a few millimeters to as much as an inch or more in diameter. The number and size of these knots appearing upon the plant determine the extent of decreased vitality produced. The nematodes, or eel worms, producing this abnormality multiply very rapidly. The females may lay as many as 100 to 200 eggs. The life cycle of an individual is only about one month.

The first noticeable symptoms of the disease may be recognized by the appearance of sickly, unhealthy plants. Knots or galls soon develop on the roots at the points of infection, and later a perfect network of small roots may be thrown out from the individual galls.

In order to eradicate this disease from the land it is necessary that the nematode worms be starved out. No plant must be allowed to grow that is susceptible to their attack. Rotation of crops will aid materially in diminishing the disease, provided that non-susceptible or resistant crops are included in the rotation. A good temporary rotation that may be used where both wilt and root knot are present in the field is as follows: First year, wilt-resistant cotton, winter oats; second year, oats, Iron cowpeas, oats or other small grain; third year, oats or other small grain, corn with Iron cowpeas or peanuts between rows.

Below is given a list of common farm crops and weeds and their susceptibility to root knot:

CROPS VERY SEVERELY ATTACKED

Bean (soy) (all varieties except Laredo)	Lettuce
Beet	Okra
Cantaloupe	Peach
Clover (bur)	Potato
Cowpea (all varieties except Iron, Brabham, Monetta, and Victor)	Tobacco
Cucumber	Tomato
	Watermelon

CROPS NOT VERY SEVERELY ATTACKED

Alfalfa	Pea (garden)
Bean (snap)	Potato, sweet
Cabbage	Radish
Cane, sugar	Strawberry
Clover, sweet	Vetch (common)
Cotton	

CROPS LARGELY OR ENTIRELY IMMUNE

Barley	Kafir
Beggar weed	Millets (nearly all)
Bean (soy) (Laredo variety excepted)	Oats
Bean (velvet)	Peanuts
Corn	Rye
Cowpeas (most varieties)	Sorghum
Grass (nearly all)	Wheat

SOME SUSCEPTIBLE WEEDS

Balloon vine	Papaya
Clover, Mexican	Mayweed
Fennel, sweet	Purslane
Maypop	

A continuous fallow for two years will starve out the insects, but this method is not to be advocated. However, clean cultivation of tilled crops, as a means of weed control, should be followed. When both wilt and root knot are prevalent in a weevil infested region Tri-Cook, Dix-Affi, and Lewis No. 63 varieties are recommended by the Georgia Station.

Cotton Anthracnose, or Pink Boll Rot (*Glomerella gossypii* Swth. Edg.). — Cotton anthracnose, or pink boll rot, was first described in 1890. At the present time it is found in all sections of the Cotton Belt. No variety of cotton is entirely free from its attack. The disease is particularly prevalent during wet spells. Dry seasons aid considerably in its control.

The causal fungus is a parasitic organism living upon and deriving its nourishment from the plant.

The disease may be first noticed as grayish or pinkish ulcers on the immature bolls. These ulcers may spread and grow in size until at least one-third of the whole boll is covered. The leaves of the infected plant show a scalded or frost-bitten appearance, then turn yellow and drop. The bark turns a reddish brown, becomes hard, and dies. The boll turns brown before it is mature, particularly that portion of the boll

which is exposed to the sun, and finally dries up and drops; or in some cases it may cling to the plant and open prematurely, producing an immature lint which is itself infected with the fungus. The plants may be attacked at any stage of growth. When the plants are young the disease may be easily mistaken by the layman for wilt.

The use of disease-free seed is one of the prerequisites of anthracnose control. The disease is spread to a greater extent by infected seed than in any other way. The spores of the disease are carried within the seed, or on the fuzz surrounding the seed. They may also be spread by wind, rains, and insects. All the stalks of diseased plants remaining in the field at plowing time should be burned or totally turned under.



FIG. 47. — Large field at Aiken, S. C., where almost all cotton plants have been killed by wilt and root knot and grass has nearly covered the ground. (Courtesy, U. S. Dept. of Agriculture.)

The Alabama Experiment Station reduced the percentage of boll infection from 11.3 per cent to 4.9 per cent by treating the seed before planting with water at 170° F. for 10 minutes; from 11.3 per cent to 9.9 per cent by treating for 22 minutes at 150° F.; and from 11.3 per cent to 5.9 per cent by charring the seed with sulphuric acid. Fall plowing and the rotation of crops, together with the use of resistant varieties, or varieties of low susceptibility, is advocated. When susceptible varieties must seed, seed should be selected for planting from plants free from the disease, and from plants several feet from an infected plant. Cleveland, Russell, Truitt, Dillon, King, Dixie, and Rowden varieties of cotton are usually free from this disease.

Cook, Brown, Blue Ribbon, Columbia, and Half and Half have been found to be most susceptible.

Angular Leaf Spot (*Bacterium malvacearum* Erw. Smith). — The angular leaf spot is also found over the entire Cotton Belt. The annual loss from this disease is not as great as in the case of anthracnose, wilt, and root knot. Only comparatively recently has much study been devoted to this disease. It is also known as black arm



FIG. 48. — Anthracnose diseased cotton seedlings. (Courtesy, South Carolina Experiment Station.)

and blight. The disease is produced by bacteria which are able to enter the uninjured epidermis of bolls and leaves. They may enter the plant at any point. The leaves, bracts, petioles, bolls, branches, and cotyledons may become infected. However, the most susceptible part of the plant seems to be the under side of the leaves.

The first indication of the disease is usually the appearance of small, watery, dark green, angular spots on the under side of the leaves. Within a few days these spots will be noticed on the upper side of the leaves also. As the disease progresses the spots enlarge but seldom get larger than three to four millimeters in diameter. The spots are particularly characterized by being somewhat angular in shape, either triangular or quadrangular. The spots never cross the large veins.

The coalescing of the individual spots along the main vein often gives to the infected portion a zigzag appearance. The spots on the cotyledons and bolls are not angular in shape, but the appearance otherwise of the spot is easily recognized by anyone familiar with the disease. The branches and petioles are occasionally attacked. Other rotting diseases enter the spots on the bolls and the principal loss in lint is due to them.

The bacteria are carried over winter on the seed of infected plants. For this reason it becomes of prime necessity that old suspected seed should either be treated with sulphuric acid before using, or not used at all.

Dry weather checks the disease, and rainy weather, especially if accompanied by wind, favors its rapid dissemination. The Upland varieties are relatively more resistant to the disease than is the Sea Island or the American-Egyptian. The estimated average loss from this disease in the Salt River Valley, Arizona, during 1917 and 1918 was 15 per cent.

Diplodia Boll Rot (*Diplodia gossypina* Cooke). — This disease was first described in 1879 by Cooke. It now occurs in all parts of the Cotton Belt, but does its greatest damage on the Coastal Plain soils in the south-central part of the Cotton Belt, particularly in Louisiana.

The disease is primarily a disease of the bolls. Occasionally the branches have been known to become infected, but other parts of the plant seem to be free from the disease. The fungus enters the boll through tissue which has been injured either by insects or some mechanical means. Within a day after the entry of the fungus the bolls take on a brownish color, which, with further progress of the disease, turns to a black. Black spores of the disease soon appear on the surface of the boll and give to the boll the appearance of an attack of some of the smuts as seen in grains. The bolls soon begin to dry out, become somewhat brittle, and remain on the plant. Those bolls attacked before half grown will not open, while more mature bolls will open, producing a black, infected mass of seed and lint. Both the seed and the lint are worthless and are seldom picked.

In 1912 Edgerton estimated the annual loss of cotton for Louisiana alone to be at least 2 per cent.

Very little is known that can be done to eradicate the disease.

Texas Cotton Root Rot (*Phymatotrichum omnivorum* Shea). — This disease is confined principally to the states of Texas, Arizona, New Mexico, Oklahoma, and California. In Texas it is the most destructive cotton disease. It is a common disease of alfalfa, cowpeas, sweet potatoes, and a host of weeds. The Houston clay soils of Texas offer a very favorable medium for its growth and development.

The cotton root rot is also a fungous disease of a parasitic and saprophytic nature. It lives and spreads in the soil.

The disease may attack the plant during all stages of its growth, but particularly during its late stages. The plants attacked will show a sudden wilting, followed by immediate death. Only a few plants may be attacked in the beginning, but the infected spot gradually grows in area year after year. There is evidence to indicate that the fungus of the diseased spots, while advancing at the outer edge in a manner similar to that characteristic of the well-known "fairy ring," dies in the center. The disease attacks and destroys the fine roots of the smaller plants and the bark of the larger ones. The plants are particularly susceptible on hot days, especially if preceded by a wet spell. The bark of the plant is not infected much above the surface of the ground. Even the fibers of the attacked plant are affected, becoming larger, with fewer and more uneven spirals.

The disease may be held in check by a rotation of crops containing no plants susceptible to the disease. Fields should not be inoculated for alfalfa with soil from an infected region. Methods of cultivation should be used that will open up and aerate the soil. The Bureau of Plant Industry, in an experiment conducted in Texas upon the effect of rotation upon the eradication of the disease, found that with a rotation of cotton, corn, and wheat the first year 95 per cent of the cotton was killed by the rot, while the fourth year, or the first year of the second rotation cycle, only 5 per cent was lost.

Black Rust of Cotton. — This disease, if it may properly be called a disease, is also known as cotton rust, mosaic disease, potash hunger, or yellow leaf blight. It is mostly confined to the sandy, humus-lacking soils of the lower Cotton Belt.

The pathological appearance of the plant is probably due to some nutritional disturbance rather than to a pathological organism. Plants become weakened, it appears, due to the lack of a sufficient amount of soluble potassium in the soil and in such condition are readily attacked by various disease organisms.

This disease usually occurs during July, August, and September, particularly during wet spells. The leaves farthest away from the main stem begin to turn yellow in spots. These spots spread and the leaf dies and falls. The bolls do not mature, and, of course, they produce lint of inferior quality.

Soil fertilization and drainage are the chief methods of eradication. The application of about 100 pounds of kainit or 25 pounds of muriate of potash will help in some cases. Preventive methods will be found to be of greater value than methods of eradication.

Blue Cotton. — Blue cotton as far as is known is not produced by a causal organism but is thought to be produced by some nutritional or physiological disturbance of the plant caused by some peculiar soil conditions. This disease or pathological condition is of minor importance. It is confined to the Sea Islands of South Carolina and to certain portions of Florida. The leaves of the plants attacked take on a bluish tinge, the plant itself becomes prostrate and develops lateral roots, and



FIG. 49. — Showing the difference in resistance of various strains of Lightning Express. The soil is badly infested with cotton wilt and root knot. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

the immature bolls are shed. The application of organic manures seems to aggravate the trouble. The application of lime and salt mud have been found beneficial in some cases. The inauguration of good drainage systems where not already in vogue is to be recommended.

Cotton Diseases of Minor Importance. — Cotton is also susceptible to a number of minor diseases, which may, during some years, in some localities, take on a serious aspect. Among these may be mentioned sore-shin (*Rhizoctonia*), leaf-spot (*Mycosphaërella gossypina* Cooke

Er.), leaf-blight (*Alternaria* Sp.), Areolate mildew (*Ramularia areola*), true rust (*Uredo gossypii*), and Ascochyta canker (*Ascochyta gossypii* Sydow).

REFERENCES

1. Cook, O. F. Cotton improvement under weevil conditions. U. S. D. A., Farmers' Bul. 501, 1912.
2. Edgerton, C. W. The rots of the cotton boll. Louisiana Exp. Sta., Bul. 137, 1912.
3. Elliott, J. A. Arkansas cotton diseases. Arkansas Exp. Sta., Bul. 173, 1921.
4. Faulwetter, R. C. The angular leaf spot of cotton. South Carolina Exp. Sta., Bul. 198, 1919.
5. Gilbert, W. W. Cotton wilt and root-knot. U. S. D. A., Farmers' Bul. 625, 1914.
6. Gilbert, W. W. Anthracnose. U. S. D. A., Farmers' Bul. 555, 1913.
7. Gilbert, W. W. Cotton diseases. U. S. D. A., Farmers' Bul. 1187, 1921.
8. Jenkins, E. W. Cotton and some of its diseases and insects. Florida Extension Bul. 15, 1919.
9. Lehman, S. C. Studies on treatment of cotton seed. North Carolina Exp. Sta., Technical Bul. 26, 1925.
10. Orton, W. A. Cotton wilt. U. S. D. A., Farmers' Bul. 333, 1910.
11. Taubenhaus, J. J., and Killough, D. T. Texas root rot of cotton and methods of its control. Texas Exp. Sta., Bul. 307, 1923.

CHAPTER XI

INSECTS OF THE COTTON PLANT

There are said to be about 465 species of insects which feed upon the cotton plant. Among this number there are only a very few which are of much importance. The total annual loss caused by these insects amounts to many hundreds of thousands of bales. Some of those which are considered the minor insects may do considerable damage during some years, and in particular localities.

Some of the Minor or Less Important Insects that Attack Cotton. —

Insects which May Injure the Leaves

- The salt marsh caterpillar (*Estigmene aceræa* Dru.).
- The Arge tiger moth (*Apantesis arge* Dru.).
- The beet army worm (*Laphygma exigua* Hbn.).
- The fall army worm (*Laphygma frugiperda* S. & A.).
- The Io moth (*Automeris io* Fab.).
- The cotton-boll cutworm (*Prodenia ornithogalli* Green).
- The leaf-cutting ant (*Oecodoma fervens* Say.).
- The cotton louse (*Aphis gossypii*, Glov.).

Insects which May Injure the Stalk

- The stalk borer (*Papaipema nitela* Green).
- The cotton stalk borer (*Ataxia crypta* Say.).
- The snowy tree cricket (*Oecanthus niveus* DeG.).

Insects which May Injure the Squares and Bolls

- The cotton square borer (*Uranotes melinus* Hbn.).
- The cotton sharpshooters (several species).
- The cotton leaf bugs (*Calocoris rapidus* Say., and others).
- The click-beetle (*Monocrepidius vespertinus* Fab.).
- The cowpea pod weevil (*Chalcodermus aeneus* Bah.).

Some of the Major or More Important Insects that Attack Cotton. —

The most important insects in the Cotton Belt are now: the cotton boll weevil (*Anthonomus grandis* Boh.); the cotton boll worm (*Heliothis ob-*

soleta Hubn.); the pink boll worm (*Pectinophora gossypiella* Saunders); the cotton worm or caterpillar (*Alabama argillacea* Hubn.); the red spider (*Tetranychus telarius* L.); cutworms; and plant lice.

The Mexican Cotton Boll Weevil (*Anthonomus grandis* Boh.). — The Mexican cotton boll weevil is generally thought to be a native of the plateau region of Central America, in which country it is supposed to have lived on the native cotton from time immemorial. It is found today in Guatemala, Mexico, United States, and Cuba. A closely related weevil is found in Arizona. The earliest record that we have of the presence of the Mexican cotton boll weevil in Mexico was made in 1843, when it was reported near Vera Cruz.

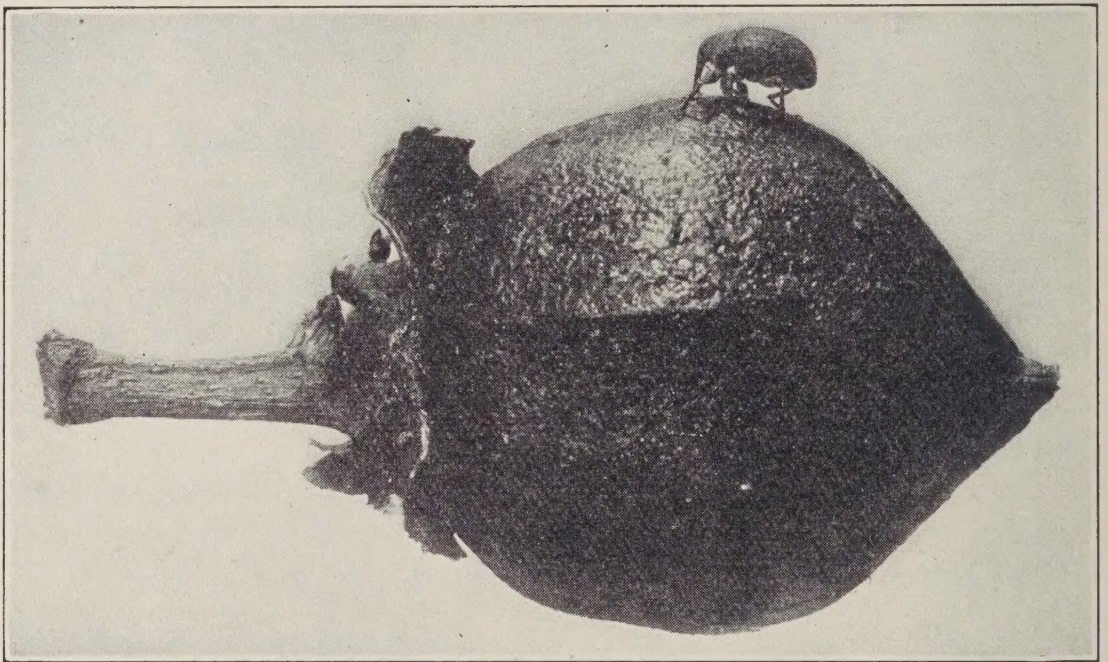


FIG. 50. — Adult boll weevil puncturing cotton boll. (Courtesy, U. S. Dept. of Agriculture.)

In 1892 the weevil was discovered in Texas where it had invaded the cotton fields in the neighborhood of Brownsville. It is thought by many that it must have been present in Texas at least two years before its presence was discovered. At this period it could easily have been exterminated had the Government known then what it knows today concerning the insect, and if the money had been available for the eradication work. Since its entrance, in 1892, it has spread gradually north and east until it has covered practically the entire Cotton Belt.

It is one of the most destructive insects that has ever entered the United States. It has been estimated that the weevil has caused a loss to the cotton planters of more than one-third of a billion of dollars since

it invaded Texas. When the weevil invades a new region the cotton production of that region is usually cut to less than half of normal. After the farmers learn something concerning the control measures, the yield is brought back to around normal. One of the results of the entrance of the weevil into a territory is the inauguration of diversified farming, and because of this in some places the boll weevil has been considered a blessing in disguise. It was this erroneous belief which caused the people of Coffee County, Alabama, to erect a monument to the cotton boll weevil a few years after its entrance into their community.

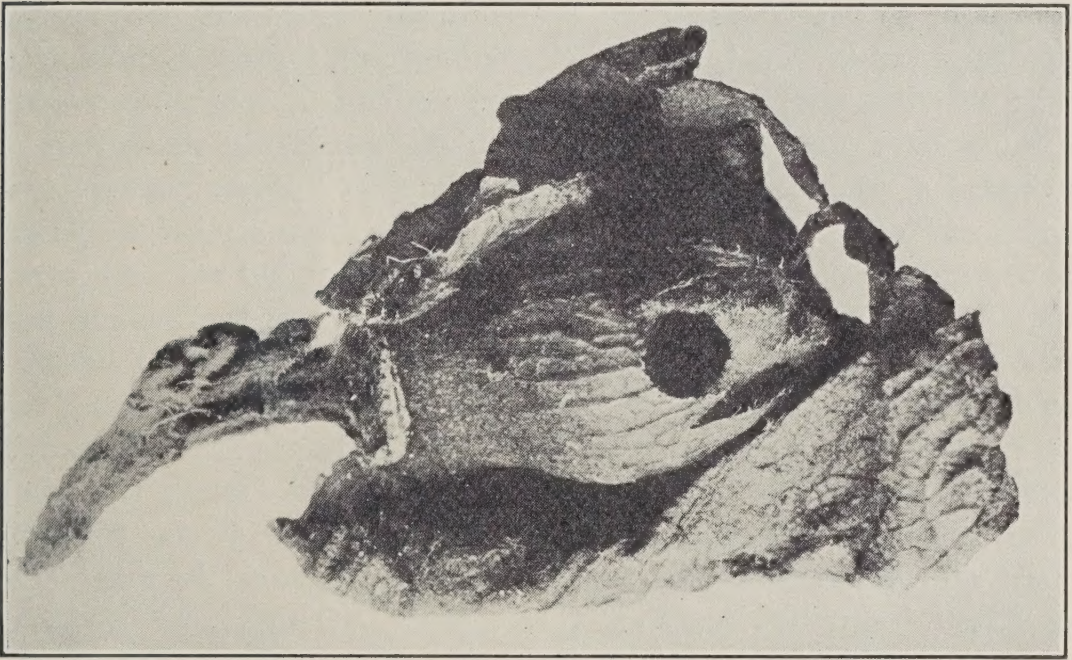


FIG. 51. — Square of upland cotton, showing emergence hole of the cotton boll weevil. (Courtesy, U. S. Dept. of Agriculture.)

The Mexican cotton boll weevil is about one-fourth of an inch in length, with a breadth about one-third of its length. To the naked eye there appears to be no difference between the males and females. The color of the insect is a blackish gray, but the shade varies with the individual, depending primarily upon its age.

As is the case with most of the cotton insects that we shall study, the life history of the Mexican cotton-boll weevil is divided into four stages: the egg, the larva or grub, the pupa, and the adult. All except the adult stage are spent within the cotton square, or within the young tender boll.

The insect spends the winter in the adult stage. It does not take any food during this period. It is slow in making its appearance in the

spring, and partly because of the cool temperature of this season, and partly because of the minority of their numbers, they do very little damage. At first they feed upon the tender leaves and terminal buds of the cotton plant. Until recently it was thought that there was no other plant upon which they could live and that if cotton were not present the weevil would soon die. However, Coad has shown that the weevil can be bred on the hibiscus. Further investigation may reveal the fact that there are other plants which can act as source of food for the weevil. Unless in hibernation, the weevil can live only six to seven days without food. When the squares develop, the weevils, both male and female, begin to feed upon them by first puncturing the outside of the square, and then eating of the contents of the square. In some cases they are known to attack the young boll. These punctures are called "feeding punctures" and may be made in any part of the square. As the season progresses other punctures are made in the squares by the females, and in these they lay their eggs. These punctures are known as "egg punctures." They are always found midway between the top and base of the square, and are always sealed with a yellowish wax. In this way they may be distinguished from the feeding punctures. The female lays an average of four eggs a day, and a total of about 140 during her life history. Only a very small percentage of these eggs hatch and reach maturity. It has been estimated that the possible number of descendants of one pair of weevils that survive the winter, during one season, is 12,755,100. All squares and young bolls that receive an egg puncture wilt, turn yellow, and fall from the plant. The egg hatches usually in about three days. The climatic conditions determine largely the length of the period of incubation. The larva is a whitish grub with a dark head and no feet. In seven to twelve days after hatching, the grub, or larva, reaches maturity and passes into the pupa stage. Here it remains three to five days, when the adult weevil emerges and eats its way out of the square. Within a few days the life cycle begins again. Weevils that develop in the young bolls are usually larger than those that develop within the squares. About two to three weeks transpire from the time the egg is laid until the mature weevil appears. With plenty of food the average life of an adult weevil is fifty days. Four or five generations are produced during a season.

About the middle of August the weevils seem to become restless, and begin to spread in all directions, either by crawling or by flying. This period is known as the dispersion or migration period. Why the weevil undertakes such a migration is not known. It was once thought that this was caused by excessive reproduction, but it now seems to be a well developed instinct for extending the weevil's range into new

territory. It is this instinct that has caused the extension of the infested area in the United States. The weevil has been known to cover a distance of forty miles in a very short period of time.

The Mexican cotton boll weevil has not been able to penetrate the high altitudes of the Cotton Belt of west Texas. This is probably due to the cold winters which are characteristic of this region. The general direction of the movement of the weevil since it entered the Cotton Belt has been north and east, but it has been greater in its eastward course than in its northward.

The first killing frost usually puts a stop to the general dispersion, and the weevils then select a place in which to spend the winter. Dead

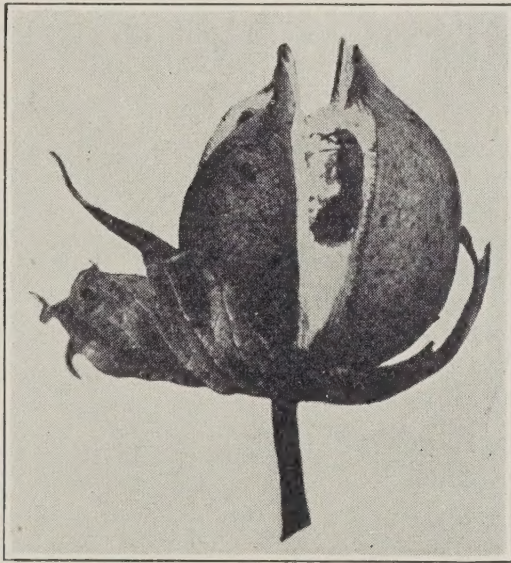


FIG. 52. — Adult boll weevil emerging from cotton boll. (Courtesy, U. S. Dept. of Agriculture.)

vegetation, fence corners, ditches, terraces, trash, anything that offers some means of protection, is sought. It is in such protected places that the weevil attempts to spend the winter. However, only one to ten per cent, depending upon the severity of the winter, survive. On the average only about six per cent of those weevils that enter hibernation live through the winter. The total number of weevils gradually increases each year from spring to autumn. Under normal weather conditions it is not until about the first of August that their numbers become prohibitive to cotton production. Excessive summer rainfall produces the most favorable conditions for weevil multiplication.

The extent of the damage done by the weevil during any individual season is dependent upon factors all of which may be classed as environmental factors. The longer the growing season of any year, and the milder the following winter, especially if followed by a wet June, July,

and August, the greater the damage done to the cotton of the next growing season.

There are forty-five insect enemies that are known to attack the weevil. Ants are known to destroy the larvæ and the pupæ. Such birds as meadow larks, blackbirds, wrens, and titmice prey upon the adults during the winter, and swallows and orioles during the summer.

No means of successfully eradicating entirely the boll-weevil has yet been found, although numbers of investigators have been employed, both by the national and state governments, to study the problem. Ofttimes extremely radical methods have been used, such as that cited by Stubbs in Louisiana Station Circular 1, page 10:

“The crop of infested cotton was pulled up, dipped in kerosene, and burned; the soil was saturated with kerosene and fired, after which it was flooded for several days.”

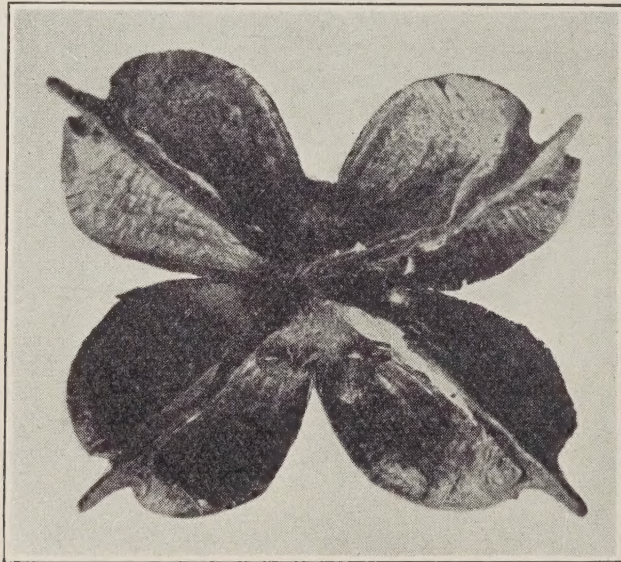


FIG. 53. — Hull of boll, with weevils found hibernating. (Courtesy, U. S. Dept. of Agriculture.)

A means of poisoning has been devised, but the mechanical apparatus necessary to apply this poison has not been entirely perfected. Because of the weevil's peculiar habit of feeding, the only satisfactory means of even partly holding the pest in check through poisoning has been by poisoning the weevils' water supply with calcium arsenate, or by applying the poison in the form of a molasses mixture. The insects require a great deal of water, and are known to use the droplets of dew which form in the axils of the leaves and on various other portions of the plant as a water source. The calcium arsenate is most successfully applied as a dust, although some success has been secured by applying it in a molasses

or syrup spray. A mixture of one pound of calcium arsenate, one gallon of water, and one gallon of syrup, applied with a mop to the top of young plants, will aid materially in reducing the number of weevils during the early part of the season.

The boll weevil can be poisoned with profit, if conditions are favorable, and if proper methods are used. Gains of five, six, and even seven hundred pounds of seed cotton per acre due to poisoning are not unusual. Dusting is a paying proposition only when: first, the weevils are really injuring the crop seriously; second, the land will produce at least one-third of a bale per acre with weevil injury eliminated; third, the farming organization is such that the poison applications will be made at the right time and in the right manner; fourth, an adequate supply of dusting machinery and poison can be secured. Poisoning is doubtfully profitable on the average farm if the cost of the calcium arsenate, the cost of the labor to apply it, and the depreciation on the dusting machinery will total per acre more than the current value of 100 pounds of seed cotton. The application of poison with aëroplanes has proved in some sections to be a profitable operation.



FIG. 54. — Cages used by the South Carolina Station in studying the life history of the boll weevil. (Courtesy, U. S. Dept. of Agriculture.)

The United States Department of Agriculture in Department Circular 274, of May, 1923, sums up its recommendations as to dusting as follows:

1. "Use only pure calcium arsenate in the form of a dry powder. Apply this only in the dust form, and purchase the powder to conform to the following specifications: not less than 40 per cent total arsenic

pentoxid, not more than 0.75 per cent water soluble arsenic pentoxid, density not less than 80 or more than 100 cubic inches per pound.

2. "Use only dusting machinery especially constructed for dusting.

3. "Dust only when the air is calm and the plants are moist. This practically means making only night applications.

4. "Use about 5 to 7 pounds of calcium arsenate per acre for each application.

5. "Start dusting when the weevils have punctured from 10 to 15 per cent of the squares.

6. "Keep your cotton thoroughly dusted until the weevils are under control. This usually means about three applications at the rate of one every four days. Then stop poisoning until the weevils again become abundant.

7. "If the weevils become abundant early enough to injure your young bolls, make one or two more applications late in the season.

8. "If you have a heavy rain within 24 hours after dusting, repeat the application immediately.

9. "Do not expect to eradicate the weevils. Dusting merely controls them sufficiently to permit a full crop of cotton, and you can always find weevils in the successfully poisoned field.

10. "Keep your cotton acreage low, and do everything possible to increase your yield per acre, as it costs just as much to dust one quarter bale per acre cotton as bale per acre cotton.

11. "Always leave an occasional portion of a cut untreated for comparison with the adjoining dusted tract. This will show how much you have increased your yield by dusting."

The time to begin the poisoning of the boll weevil is determined by the amount of square infestation in the field. Of course, the infestation will vary in the different parts of the field, being influenced by many factors, such as the proximity of hibernation quarters such as ditch banks, fence rows, woods, etc. Therefore, it is necessary, in order to secure an average infestation for a field, to make at least five determinations in various parts of the field, and from these results secure an average for the field.

The determination of the percentage of infestation is determined in the following manner. At least five determinations should be made in those portions of the field which represent average plant and stand conditions. A good method to follow is to make one determination near the center of the field and one near each corner, care being taken that no determination be made on the very edge of the field. Where determinations are to be made consecutively throughout the season the counts should be made at approximately the same localities each time. It is desirable to make weekly determinations. If the field is being poisoned a record should be secured before each application.

Having selected the locality, pass down the row and examine every

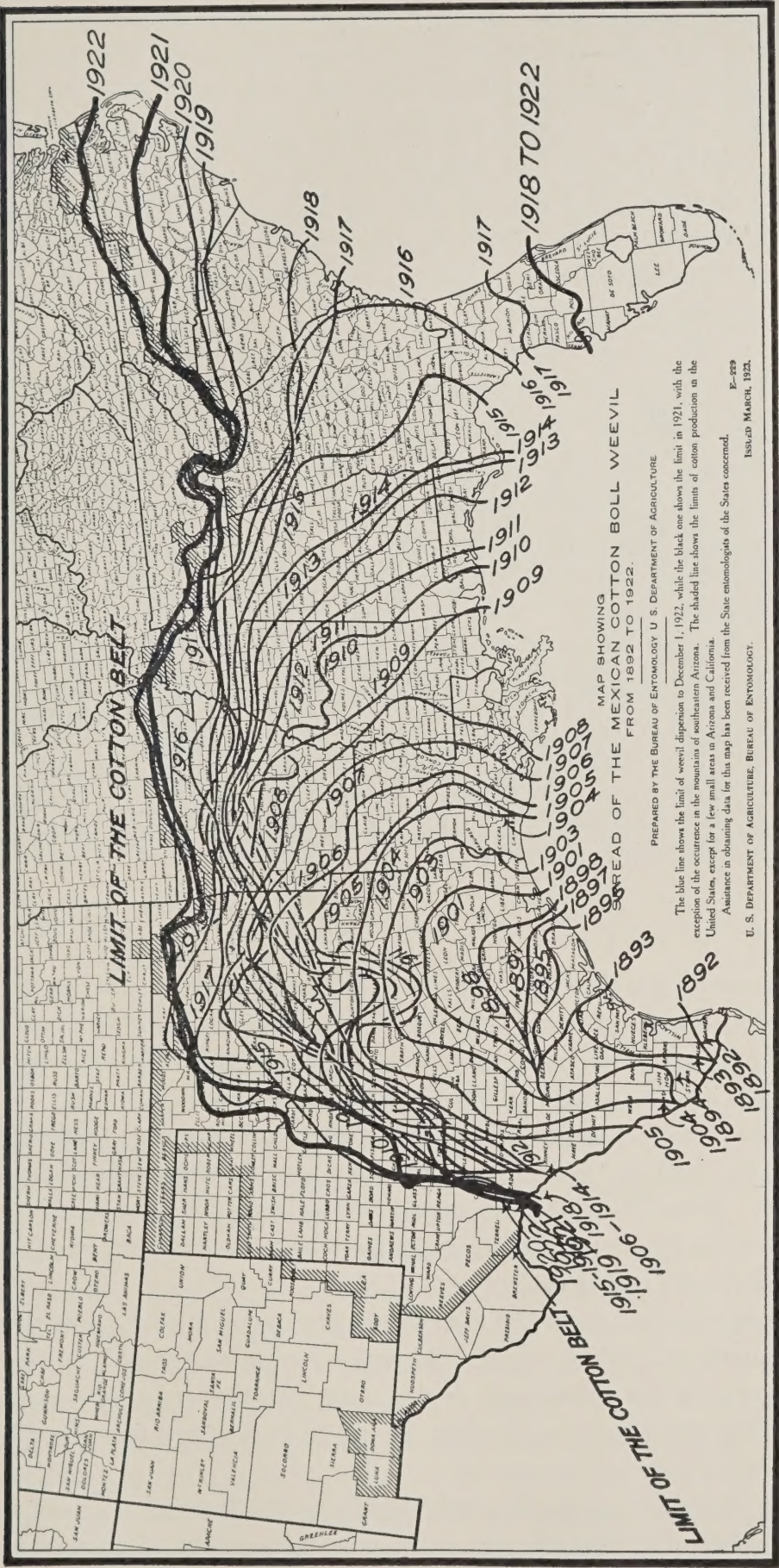


FIG. 55. — Map showing spread of the Mexican cotton boll weevil from 1892 to 1922. (Courtesy, U. S. Dept. of Agriculture.)

square that is large enough for a weevil to puncture, on every normal plant, until 100 squares have been examined. As the examination proceeds, pick off the punctured squares and leave the sound ones. More plants will have to be examined in order to secure 100 squares during the early part of the season than later. It is advisable not to examine over about 25 plants within any one row. If more plants than 25 have to be examined in order to find 100 squares, that portion of the next row lying parallel to the portion of the row already examined should be used for further examination.

Having made counts in at least five localities within the field, the percentage of infestation may be determined according to the following hypothetical case:

	Total No. squares examined	No. squares not punc- tured	No. squares punctured
Center field.....	100	80	20
Northeast corner.....	100	75	25
Northwest corner.....	100	90	10
Southeast corner.....	100	85	15
Southwest corner.....	100	95	5
	— 500	— 425	— 75

Divide the total number of squares punctured by the total number of localities examined, and this will give the average number of punctured squares per hundred squares examined, or the percentage of infestation. In the above case the infestation totals 15 per cent.

Plant lice often rapidly multiply following heavy and regular applications of calcium arsenate, and may do considerable damage to the cotton. Nicotine sulphate added to the calcium arsenate has been found effective in lice control, and the calcium arsenate remains as effective in weevil control.

Besides poisoning, there are two other groups of factors that must be kept continually in mind. First, the crop must be pushed to maturity before the period of maximum destruction arrives, in July or August. Second, every possible means must be used to destroy the weevils and to keep down their numbers.

In order to induce earliness, only fertile, well-drained soils should be planted to cotton. Where it is necessary to fertilize, fertilizer should

be used judiciously. The preparation of the seedbed and the subsequent cultivations should be of the very best. Good yielding early varieties must be used in all cases. Varieties of cotton such as the King, Mitchell, Broadwell, and Simpkins give excellent results in some localities because of their earliness. The greatest objections to these varieties are that their bolls are small, the lint is short, and the yield is low. Such varieties as the Cook, Cleveland, Triumph, Truitt, Dixie, Webber,



FIG. 56. — Dusting cotton with hand guns. (Courtesy, U. S. Dept. of Agriculture.)

Lone Star, Acala, Express and Meade have been found to produce a fairly good yield of early cotton. For weevil conditions varieties should be selected that set fruit early and then continue to grow and furnish squares upon which the weevils can feed. When there are plenty of squares the weevils do not attack the young bolls. A large percentage of the blossoms that open within ninety days after planting should set fruit and reach maturity.

The average adult weevil destroys from ten to twelve squares a day, and it becomes absolutely essential that the number of weevils be kept as low as possible. In some sections it has been found satisfactory to pick the weevils from the buds of the young plants early in the spring. Some farmers pay children one cent a weevil for all they can collect, and so much a gallon for punctured squares. If the squares that contain the immature stages of the weevil are destroyed, the number of adult weevils can be held in check. When a square which contains an immature weevil is allowed to receive the direct rays of the sun for a

definite length of time, the weevil is likely to be killed if the soil is dry and the temperature high.

Smith and Newell, of the Florida Station, have suggested a method of weevil control known as the Florida method, which has proved beneficial for Florida conditions, but which appears not to be adaptable to other sections. The principle of the method is to strip every square from the young plant and immediately poison with arsenate of lead, either in the form of a dust or in a syrup poison. The few weevils existing at the time of poisoning are then forced to feed more freely on



FIG. 57. — Type of dust cloud desired for successful treatment of cotton plants. (Courtesy, U. S. Dept. of Agriculture.)

the tender poisoned leaf buds. In this way it is assumed that most of the weevils that survive the winter are killed. The cotton crop of the season is made from those squares which are produced after this treatment.

The expression "boll weevil cotton" is used in parts of Texas to describe an abnormal luxuriance of the plants induced by the boll weevil. During certain years, when the weevils occur in great numbers and most of the flower buds are destroyed, the plants grow much larger and show a deeper green color than in normally productive fields. During the latter part of the season boll weevil cotton produces large numbers of sterile defective involucres, lacking the essential organs of normal cotton flowers. So rank becomes the foliage that the lanes

between the rows are shaded continuously and, as a result, the weevil larvæ in fallen buds are protected by the shade, instead of being killed by exposure to heat and dryness. Closer spacing is advocated in order that the secondary stalks may be suppressed.

Since late side dressings of soluble nitrogen delay maturity, applications of soluble nitrogen must be made early, or omitted entirely, under boll weevil conditions. The farm should be kept free from places in which the weevil can hibernate. All cotton stalks should be turned under as soon as possible after the cotton is picked. If this method of weevil control is practiced the immature weevils which may be in the late squares and bolls will be turned under with the cotton and thereby killed.

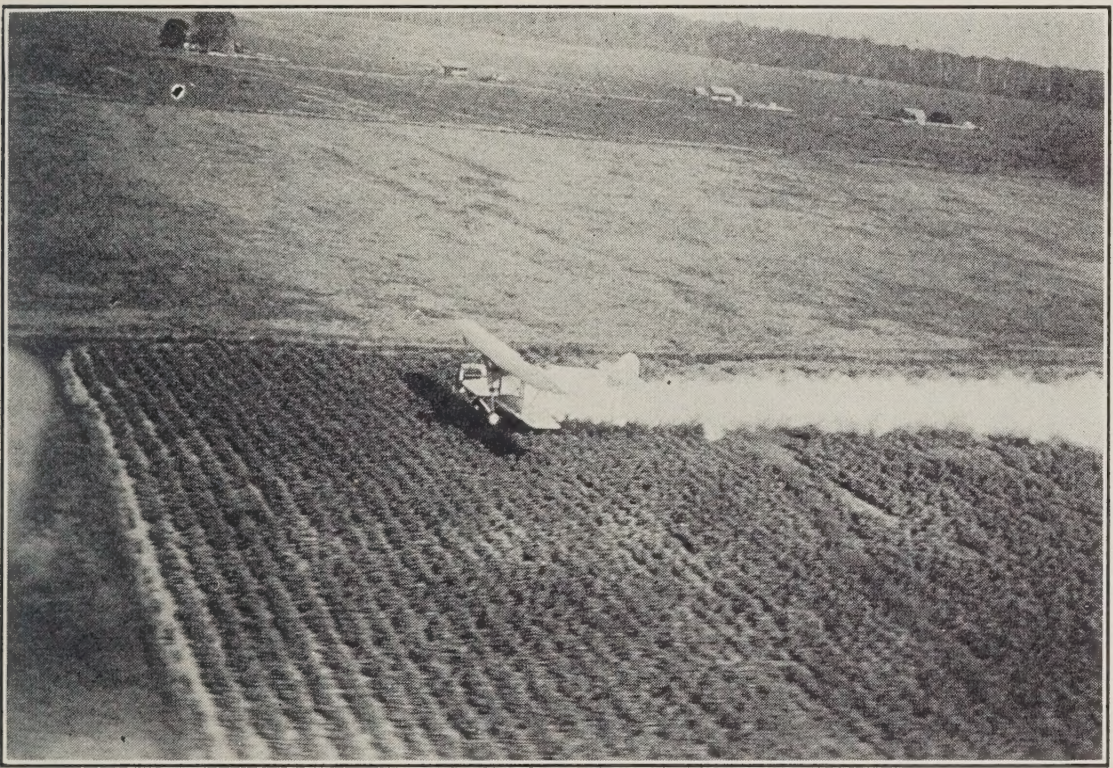


FIG. 58. — A field of cotton being dusted from an aëroplane. (Courtesy, U. S. Dept. of Agriculture.)

The recommendations of the Association of Southern Agricultural Workers as to boll weevil control measures for 1924, are given as follows:

“ Boll Weevil Control

“ 1. That one pre-square poison application be given wherever hibernated weevils appear fairly abundant on the young cotton (20 or more weevils per acre). This treatment should be applied at the first indication of squaring. The treatment may be repeated if appreciable

numbers of weevils are evident before the fruit blooms appear. At this time and for this particular treatment, the grower may use either:

“(a) Home-mixed, molasses-calcium-arsenate mixture (usual formula 1 pound of calcium arsenate, 1 gallon of molasses, 1 gallon of water, or, with extremely heavy infestation and with frequent rains, a stronger and more expensive mixture, containing 2 pounds of calcium arsenate, 1 gallon table quality of syrup and one-half gallon of water, which may give quicker killing and better control). In syrup mixtures the syrup must always be sweet or unfermented and should be applied within 24 hours after being mixed. The usual application required is about 1 gallon per acre and is applied by using a homemade mop to sprinkle a few drops into the tip of the plant, or:

“(b) Straight calcium arsenate applied either by machine, or, at this pre-square stage only, the dust may be shaken from a bag with equal effectiveness while weevils are feeding in the tips of the plants. The bag treatment is not effective on large, fruiting cotton.



FIG. 59. — A commercial aëroplane that is used in dusting cotton. (Courtesy, U. S. Dept. of Agriculture.)

“Any pre-square treatment, or the Florida Method, may need to be followed up by later dusting also to secure maximum profits through protection against reinfestation, such as will always be liable to occur.

“2. For the treatment of fruiting cotton generally, and especially on soils capable of producing one-third bale or more per acre normally, the calcium arsenate dusting method is most reliable and profitable and is strongly recommended in preference to late season applications of any syrup mixtures or other liquid poisons yet tested.

“Dusting should begin when 10 per cent of the squares show weevil puncture and at least three applications of 5 pounds per acre should be

given with proper machinery and at 4 and 5-day intervals. Thereafter dust should be applied only as needed to keep infestation below 20 per cent until after a full crop of bolls has been set and has become well grown.

"3. The Florida Method, though not yet as extensively tested as may be desirable under a wide range of soil fertility, fertilizer applications and varying climatic conditions, seems to be applicable to the coastal areas and other areas where hibernated weevils are likely to be extremely abundant, the early summer rainfall normally high and where yielding capacity of soils is relatively low and where, therefore, heavier expenditures for poisoning cannot be incurred.

"4. Early picking of the crop should be followed wherever possible by immediate deep burial of the green cotton stalks to destroy the food supply of adult weevils, to prevent the emergence of the late fall generations and to remove favorable shelter conditions for weevil hibernation. Exceptions may be made where winter erosion of soil follows fall planting.

"5. Community-wide action in weevil control may add greatly to the effectiveness of each of these measures. Therefore, the coöperation of all growers whether owners or tenants, should be enlisted in putting into effect this fundamental program for weevil control for 1924.

Variety and Cultural Practices

"1. Prepare ground early so as to have a firm, smooth, well settled seed bed at planting.

"2. Delay planting until danger from frosts and cold is past and the soil is warm enough to give prompt germination and vigorous early growth. Plant one bushel or more seed per acre. A perfect stand is immensely important. As nearly as practicable all cotton in the same community should be planted at the same time and in the same variety.

"3. Plant if possible only selected seed of an improved variety having a staple not less than $\frac{7}{8}$ -inch recommended by the State Experiment Station for the section and soil in question. It is definitely proven that increased yields worth from \$10 to \$40 per acre may be secured by planting selected seed.

"4. Width of cotton rows should be from three to four feet, depending on the fertility of the soil, spacing in the row should be from 8 to 12 inches with 1 to 3 stalks to the hill. The closer spacing and thicker are recommended for the poorer soils and for sections which commonly suffer from heavy weevil infestation and frequent summer rains.

"5. Cultivate shallow and often enough and as late as necessary to keep the crop entirely free from weeds and grass.

Soils and Fertilizers

"The committee recommends that for the production of cotton in 1924, every possible encouragement be given to the selection of the best soil on the farm. To this end, we would stress the use of only the well drained, fertile lands and when available, the early soils.

"We also recommend the further use of soil improving practices. To this end, we urge the growth of summer legumes and of winter cover

crops as often as is practicable in the cropping system to help supply nitrogen and organic matter.

“As for the kind and quantity of fertilizers to be used on various soil types, we advise the farmer to be guided by the recommendations of the experiment stations.



FIG. 60. — The plot on the left has been dusted with calcium arsenate. The plot on the right has not been dusted. (Courtesy, U. S. Dept. of Agriculture.)

Plant Diseases

“When soil is infected with cotton wilt fungus we recommend that good seed of Dixie Triumph, Toole, Lewis 63 and other varieties known to be highly resistant to wilt and early enough to prove productive under boll weevil conditions be planted. Where root knot and wilt are present we recommend that a rotation be practiced to rid the soil of nematodes, followed by the best wilt resistant varieties. A three-year rotation may include corn, small grain, peanuts, velvet beans, and Brabham or iron peas.

“For anthracnose control we recommend two-year rotation and the use of seed free from the disease.

“Where angular leaf spot, black arm and bacterial boll rot are serious we recommend delinting the seed with sulfuric acid.

Economics of Cotton Production

“Not more acres but more cotton to the acre; greater efficiency in every phase of cotton production; a well balanced, self-supporting farm unit; soil building; liberal fertilization and coöperative marketing were recommended.”

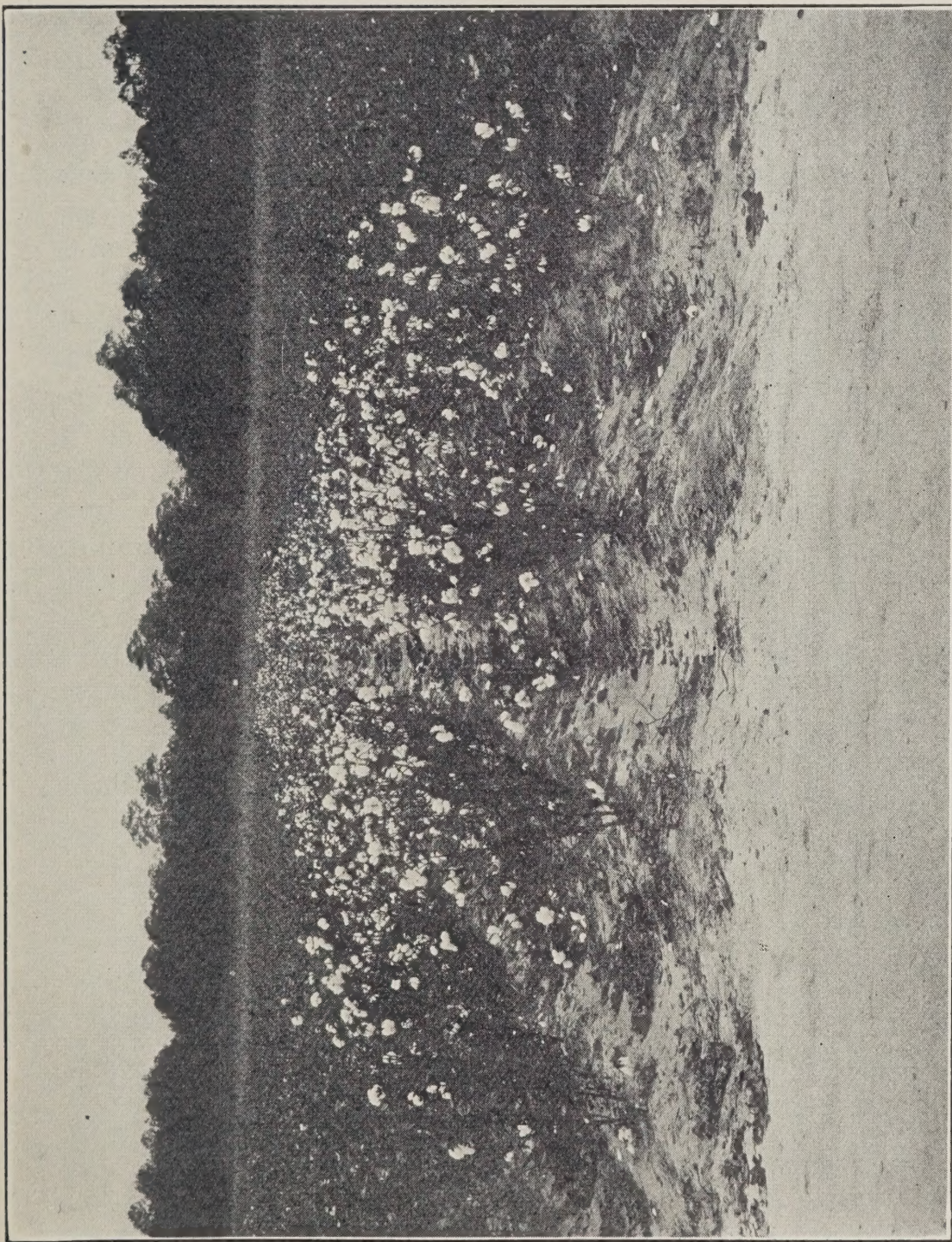


Fig. 61. — An excellent "top" crop of Cleveland cotton produced under weevil conditions. This block of cotton shows that the weevil have been kept under control. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

The Cotton-Boll Worm (*Chloridea obsoleta* Hubn.). — The cotton-boll worm was one of the earliest insects to cause any considerable damage to the American cotton crop.

Besides cotton, the worm attacks tobacco, tomatoes, and corn. It is also known as the corn ear worm. Where corn and cotton are found growing in close proximity the corn will be attacked in preference to the cotton. Cotton is usually attacked just about blooming time.

The life history of the insect is divided into four stages: the egg, the larva, the pupa, and the adult. The eggs are laid on the tender shoots and unfolded leaves of the cotton plant. In the case of corn the eggs are laid on the silk of the young ears. The eggs hatch in from two to eight days. The larvæ grow very rapidly until they reach a length of 1 to $1\frac{1}{2}$ and 2 inches. They vary from a pinkish-green to a light black in color. On the cotton plant, as soon as the eggs are hatched, the larvæ feed upon the leaves and tender stems, but soon attack the young bolls, puncturing the outer part of the boll and then destroying its contents. They may destroy one boll and then come out and attack another. In this way one or more bolls are destroyed by each larva. On corn as soon as the eggs are hatched the young larva burrows into the ear and attacks the maturing kernels.

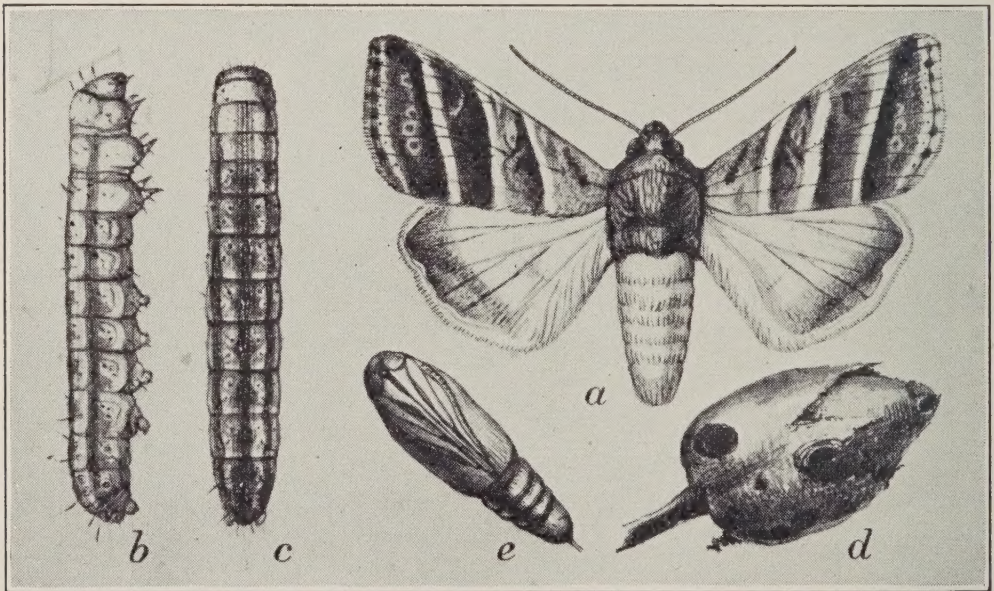


FIG. 62. — Various stages in the life history of the cotton boll worm; *a*, moth; *b* and *c*, larvæ; *d*, punctured boll; *e*, pupa. (Courtesy, U. S. Dept. of Agriculture.)

After sixteen to eighteen days the larvæ complete their growth, drop to the ground, and burrow into the soil two to five inches and enter their pupa stage. The insect remains in this stage, if during the

summer, twelve to fifteen days; if in the early fall, all winter. When this time has been completed, the adult emerges as a brownish yellow moth, about one to one and one-half inches from tip to tip of wing. The moth flies at dusk, or after dark, feeding upon the nectar of flowers. A single female may lay more than a thousand eggs during a season.

The average life cycle of the insect during the summer is about thirty days. There may be five or more generations during a single season.



FIG. 63. — Pink boll worm; adult. (Courtesy, U. S. Dept. of Agriculture.)

Since the insect remains in the pupa stage during the winter, it may be killed by fall or winter plowing. As the insects prefer corn to cotton, cotton fields are invaded only after the corn of nearby fields has passed the roasting ear stage. For this reason corn can be planted late in adjoining fields, or even in the cotton field, as a trap crop. As soon as the crop has served its purpose, however, it should be cut and fed to stock. Even if this is not done, the congregating of worms within one ear tends to destroy the insects, for when in close contact with one another they devour each other. Practices that will tend to produce early cotton, such as early planting, early varieties, use of fertilizers, etc., will be found of great help. The application of arsenate of lead to the plants during the latter part of July and first of August will help to exterminate the young worms before they are large enough to enter the boll. The poison should be applied when the dew is on the plants.

The most important enemies of the insect are wasps and robber flies.

The Pink Boll Worm (*Pectinophora gossypiella* Saunders). — The pink boll worm is found in the islands of the Pacific, in Asia, Africa, South America, Mexico, and Texas. The outbreak in Texas did not occur until 1916. It is thought that this insect was introduced into this country from the cotton growing district of Laguna, Mexico, by a severe storm that occurred in 1915. As soon as its presence was discovered, the national government adopted strict methods whereby the further spread of the insect could be retarded and its eradication made possible. Considerable areas of Texas are at the present time under strict quarantine.

Although this insect may be classified as one of the minor cotton insects in the United States, it may develop into our most destructive insect pest.



FIG. 64. — On the left, normal cotton boll. On the right, boll injured by pink boll worm. (Courtesy, U. S. Dept. of Agriculture.)

Unlike the cotton boll weevil, the boll worm spreads only to a very limited extent by dissemination from field to field. Its entrance into a new territory usually takes place through infested seed. In this way the pest was introduced into South America and Mexico from Egypt, and in a like manner it is supposed to have reached Asia from Africa.

The adult is a small dark brown moth. In infested regions it is frequently seen in the cotton fields, gins, and warehouses. Like all moths, it usually stays in hiding during the day, and comes out at night to feed and lay eggs. The eggs may be laid on any part of the plant. However, they are most commonly laid near the apex of the green bolls. One to four eggs are commonly seen on a boll. The eggs may be laid singly or in groups. Each adult female is capable of laying over 100 eggs. The eggs hatch in eight to twelve days after they are laid. The larvæ, at first, are very small, glossy white, and have brown heads. As they become older they take on a pinkish hue. As soon as the eggs

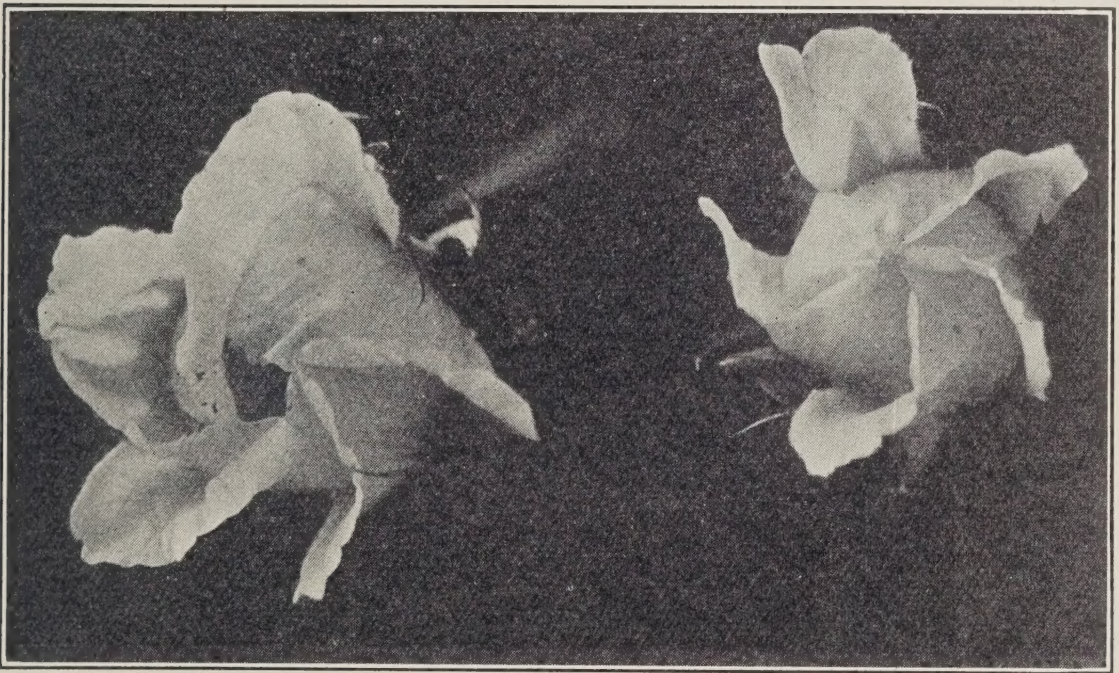


FIG. 65. — Characteristic rosette appearance of cotton flowers infested with pink boll worm. (Courtesy, U. S. Dept. of Agriculture.)

hatch the larvæ tunnel into the boll and live for a time by feeding on the partitions that separate the locks. Later they attack the seeds. The larva may confine itself to one locule of the boll, or it may invade all of them. One or more larvæ may be found in every infested boll. After partly destroying one boll a larva may leave it and attack another. The leaves and shoots of the plants are not attacked. The infested bolls become discolored, deformed, and may become infected with some of the boll rots. The lint of infested locks may become practically worthless, because of the tunneling habits of the larvæ. In twenty to thirty days after hatching the larva enters the pupa stage. This stage may be passed within the boll or in the soil. If within the boll, a tunnel is cut to the exterior of the boll by the larva before it pupates, in order

that the escape of the adult will not be hindered. Those that pupate within the seed become a source of infestation if those seed are taken to a non-pink boll worm territory without first being fumigated. The adult appears, if in the summer, in about twenty days after the larva pupates; if during the fall, not until the following spring. The average life cycle of the insect is thirty-one days in the summer.

In order to prevent the introduction of this insect pest, all seed obtained from infested regions must be fumigated. Where the insect has already entered a region, the burning of all the old stalks, the fumigation of gins, oil mills, and seed warehouses, and the fumigation of all seed kept on the plantations will help to hold it in check. In Egypt the burning of all old cotton stalks is required by law.



FIG. 66. — Holes cut through partition walls where larvæ of pink boll worm goes from one lock to another. (Courtesy, U. S. Dept. of Agriculture.)

The Cotton Leaf Worm, or Cotton Caterpillar (*Alabama argillacea* Hubn.). — At one time this was one of the most destructive insects of the cotton plant. The larva stage of the insect is commonly known as the “army worm” or “inch worm.”

As in the case of the cotton boll worm, the life history of this insect may be divided into four parts. The eggs are laid on the plant and hatch within two to five days after being laid. The larvæ, or cater-

pillars, grow very rapidly, reaching one to one and one-half inches in length when full grown. The full grown caterpillar is dark green in color, and striped with black. As soon as it is mature the worm wraps itself in a leaf, or parts of a leaf, and spins a silk cocoon, within which it spends its pupa stage. From this stage the adult emerges in about ten days as a brown moth, commonly known as a "candle fly." Like all moths, it feeds and lays its eggs at night. These eggs are laid on the leaves of the plant. The female may lay four hundred to six hundred eggs during its season. There are about three to seven generations of insects during a single growing season.

The cotton leaf worm feeds upon the leaves and tender shoots of the cotton plant. It may attack the plant early in the season, but it does not become a serious pest until late in the summer. This is due to the fact that the number is greater in the latter part of the season.

Owing to its feeding habits, the cotton leaf worm can easily be controlled by dusting and by the use of poisonous sprays. Three pounds of arsenate of lead is sufficient to eradicate the worms from an acre. The application should be made at the beginning of each crop of worms.

The extent of the damage done by this insect depends upon the number of caterpillars present. The foliage from the cotton of an entire farm may be stripped sometimes within a week, and the worms hunting for food will scatter to surrounding fields.

The Red Spider (*Tetranychus telarius* L.). — This insect is found over the entire Cotton Belt. The outbreaks generally occur in spots, or localities. Infested patches of four to five acres, or less, are frequently seen. Very rarely are areas as large as whole counties attacked. The insect is often found to be a serious pest in greenhouses.

The total damage done by the red spider is greater in some years than in others. Hot, dry seasons are favorable and cold, wet seasons are detrimental to its multiplication.

The red spider is known to attack 153 kinds of plants, 55 per cent of which are cultivated crops. Some of the most common plants which they attack are cotton, clover, corn, garden bean, tomato, dahlia, hollyhock, sow thistle, cultivated violet, hedge nettle, sweet pea, carnation, onion, morning glory, nasturtium, wild vetch, ironweed, evening primrose, strawberry, pokeweed, Jerusalem oak, and wild geranium.

The insect is not a spider, but a web-spinning mite of such small size that it is hardly discernible with the naked eye. The females are about $\frac{1}{15}$ of an inch in length, and vary in color from a yellow to a black. They are characterized by having a large dark spot on each side of their backs. The males are much smaller than the females, and are of a dull salmon color. They also have spots on their backs, but these



FIG. 67. — Cotton leaf worm; stages and work. (Courtesy, U. S. Dept. of Agriculture.)

are rather indistinct. Both the males and females have eight legs and no wings.

The males and females occur in great numbers upon the infested plants. They attack the plant principally on the under side of the leaf. The first symptom of attack that is usually noticed is the presence of blood-red spots on the top side of the leaves. These spots may enlarge until the whole leaf becomes affected. The leaf finally turns a yellow brown, curls up, becomes somewhat brittle, and drops from the plant. Within a short time after the leaves drop the entire plant is usually dead. The bolls which are nearly mature may open, but they produce a very poor fiber. The attack is somewhat similar on all other plants which are subject to infestation.

The insect feeds after pushing its feeding parts well into the leaf. Because of this habit stomach poison sprays cannot be used in its eradication. At the points of attack the insects spin a very fine web under which large numbers congregate and attack the plant. Doubtless it is from this habit of spinning a web that the insect got its name, spider. The life cycle of the insect is usually completed in nine to eleven days during the summer months.

As soon as the cotton dies in the fall, the insects migrate to such wild plants as may offer protection and food through the winter. They spread from place to place by crawling. They can travel over a smooth surface at the rate of five inches per minute, or 600 feet in twenty-four hours.

The winters are spent chiefly as matured females on such plants as the cultivated violet and the pokeweed. These two plants in particular furnish winter food, and outbreaks in the spring can usually be traced to one or both. During mild winters all stages of the life cycle of this insect may be found.

In the spring infestation takes place from the wintering places, and usually spreads out in a fan-shaped area from this center. New points of infestation may be, and are, produced when the insect is bodily transferred by such agencies as strong winds, animals, birds, and insects.

The red spider is known to be attacked by thirty-one predacious enemies. Included among these enemies are mites, thrips, bugs, lace-wing flies, midges, syrphid flies, lady-beetles, and caterpillars.

The principal means of control for red spider are:

1. Give the plants plenty of room both in the row and between the rows.
2. Invigorate the plants by the use of commercial fertilizer where needed.
3. Keep down all weeds in the fence corners and on the terraces.

Herbicides may be used very successfully in this connection. A spray made up of one pound of sodium arsenate to twenty gallons of water will kill all weeds. Precautions should be taken to keep all livestock away from such weeds after they have been sprayed.

4. Destroy the first cotton plants that show infestation. This may be done by collecting and burning them.



FIG. 68. — Cotton plant in an early stage of infestation by the red spider. (Courtesy, U. S. Dept. of Agriculture.)

5. Use insecticides. There are five insecticides that may prove of value in the eradication of the red spider: (1) potassium sulphide (1 oz. to 2 gals. of water); (2) lime sulfur (1 gal. of lime sulfur solution to 100 gals. of water); (3) nicotine sulphate (one coffee cupful to 50 gals. of water, to which should be added 3 lbs. of a good grade of laundry soap that does not contain coal tar or naphtha); (4) kerosene emulsion; (5) flour paste (1 gal. stock paste to 12 gals. of water). At least two applications should be made, about one week apart, so that all insects

which were in the egg stage at the time of the first application may be killed at the second.

Cotton Root Louse (*Aphis maidi radidis* Forbes). — The cotton root louse is found over the entire Cotton Belt, but does the greatest damage in the Coastal Plain Province.

It is a sucking insect, and when congregated in large numbers on the roots of its host it sucks the plant to such an extent that it becomes stunted and wilted. The insect passes the winter in the egg stage. The eggs, as well as the aphides themselves, are cared for by ants. In the winter the eggs are carried below the frost line during the cold spells and brought again to the surface during warm spells. The eggs hatch early in the spring, and the young are taken by the ants to wild plants in the vicinity until crops of cotton or corn become available. The second generation of the insect is winged, and it is during this generation that the insect may disseminate itself through flight.

The insect may easily be controlled by frequent light cultivations. These will so disorganize the ants that they will give more time to organization after each cultivation than they will to taking care of the aphides. The louse does not feed on the small grains or upon cowpeas. Rotations containing these and other crops will aid materially in their eradication.

Cutworms. — Cutworms are the larval stage of several species of moths. The principal damage to cotton is usually done just before or just after chopping. They generally attack the plant just at the surface of the ground, and kill the plant by cutting the stalk in two. Greater damage is done during seasons which follow a wet fall than during seasons that follow a dry fall. All of these insects spend their larval stage in the soil during the winter, so that large numbers of them may be killed if fall or early spring plowing is practiced. When these insects become excessively noxious they may be combated successfully by scattering through the fields bunches of green vegetation which have been poisoned with Paris green or white arsenic.

Cotton-dusting Machinery. — Remarkable has been the progress made in the development, during the last few years, of dusting machinery, suitable for treating cotton with calcium arsenate dust. Four years ago, in 1921, there was not a suitable dusting machine on the market, while today there are forty or fifty.

The dusting machinery proper consists of a feeding mechanism, a dust container or hopper, and a fan or blower. The arrangement of these parts varies in machines of different makes. These machines may be roughly classified into three groups: (1) hand-driven machines, (2) traction-driven machines, and (3) engine-driven machines.

The power for the hand-driven machines is furnished by turning a crank. These machines may be subdivided into two groups, — the hand-guns, and the saddle-guns. The hand-guns usually hold 2 to 7 pounds of poison, and when full should not exceed 20 pounds in weight. The machines will usually last one to three years, but are the least satisfactory of the dusting machines, because of the difficulty of operation. One man with one gun can take care of about eight acres of cotton during a season.

The saddle-guns are similar to the hand-guns but are designed to be carried on the back of a mule. They are comparatively cheap and can be taken into places where no machine mounted on wheels could be satisfactorily used. One man with a saddle-gun should be able to take care of 40 to 50 acres of cotton during one season.

There are also two general types of traction-driven machines, — the one-mule machine and the cart duster. The one-mule machine gives splendid efficiency and will dust from 15 to 20 acres a day, or night. These machines may have one, two, or three wheels. The operator walks behind the duster and steadies it by means of handles similar to those of a plow. Such a machine will take care of 50 to 60 acres of cotton for the season.

The cart-duster is a two-horse duster mounted on two wheels. The driving power for the machinery is furnished by these two wheels. One of these machines will treat 25 to 30 acres in a day, or night, and take care of 75 to 100 acres in a season. Because it is somewhat difficult to drive at night, a rather elaborate lighting equipment is required.

The engine-driven machine or power-duster consists of a four-wheel wagon with an engine and a dusting machine mounted on the platform. This type of duster carries a lighting equipment and an extra barrel of dust. Two men are required to operate it, — one man to drive, and the other to operate the engine and dusting apparatus. This duster is capable of caring for 50 to 60 acres of cotton in a day, or night, but has not proved generally satisfactory for cotton dusting. It is heavy, cumbersome, and can be used to advantage only in very large, level fields.

Coöperation between farmers and owners of aëroplane dusters has made dusting with aëroplanes a feasible and profitable undertaking in many sections.

Much worthless cotton dusting apparatus may still be found on the market. For this reason, farmers should investigate carefully all machines before buying.

REFERENCES

1. Armstrong, G. M.; Moreland, R. W.; and Gaines, R. C. Progress report on studies on boll weevil control under South Carolina conditions. South Carolina Agr. Exp. Sta., Bul. 223, 1925.
2. Barre, H. W. Boll weevil investigations in 1923. South Carolina Agr. Exp. Sta., Cir. 31, 1924.
3. Bishop, F. C., and Jones, C. R. The cotton boll worm. U. S. D. A., Farmers' Bul. 290, 1907.
4. Busck, August. The pink boll worm, *Pectinophora gossypiella*. Jour. Agr. Research, XIX, No. 10, p. 343, 1917.
5. Coad, B. R. Recent experimental work in poisoning cotton boll weevils. U. S. D. A., Bul. 731, 1918.
6. Hall, E. E., and Armstrong, Geo. M. Cotton experiments at Florence. South Carolina Agr. Exp. Sta., Bul. 222, 1926.
7. Howard, L. O. The red spider on cotton and how to control it. U. S. D. A., Farmers' Bul. 831, 1917.
8. Hunter, W. D. The boll weevil problem. U. S. D. A., Farmers' Bul. 344, 1911.
9. Hunter, W. D. The boll weevil problem. U. S. D. A., Farmers' Bul. 848, 1917.
10. Hunter, W. D. The pink boll worm with special reference to steps taken by the Department of Agriculture to prevent its establishment in the United States. U. S. D. A., Bul. 723, 1918.
11. Hunter, W. D., and Coad, B. R. The boll weevil problem. U. S. D. A., Farmers' Bul. 1329, 1923.
12. Marlatt, C. L., *et al.* Services and Regulatory Announcements. U. S. D. A., S. R. A., Fed. Hort. Bd. 50, 51, 52, 55, 56, 1918.
13. Mexican cotton boll weevil. U. S. D. A., Bur. of Entomology, Bul. 114, 1912.
14. McDonnell, C. C.; Smith, C. M.; and Coad, B. R. Chemical changes in calcium arsenate during storage. U. S. D. A., Bul. 1113, 1922.
15. Quaintance, A. L., and Bishop, F. C. The cotton boll worm. U. S. D. A., Farmers' Bul. 212, 1905.
16. Sanderson, E. D. Insects mistaken for the Mexican boll weevil. Texas Agr. Exp. Sta., Bul. 74, 1904.
17. Sanderson, E. Dwight. Miscellaneous cotton insects in Texas. U. S. D. A., Farmers' Bul. 223, 1905.
18. The cotton plant. U. S. D. A., Office of Experiment Sta., Bul. 33, 1896.
19. Worsham, E. L. The cotton red spider. Georgia Agr. Exp. Sta., Bul. 92, 1910.

CHAPTER XII

HARVESTING OF COTTON

The gathering, or the harvesting, of the seed cotton after the bolls are open is known as picking. It is the most expensive operation in the production of cotton. One man can plant and cultivate twenty to thirty acres of cotton, but it takes four to five good pickers to gather the average crop from the same acreage.



FIG. 69. — A characteristic cotton picking scene. (Courtesy, U. S. Dept. of Agriculture.)

Time of Picking. — In pre-boll weevil days picking was begun during the latter part of August and continued throughout the winter. The last picking was sometimes delayed until the following spring. However, the largest part of the crop was picked during the months of September, October, and November. The greater part of the crop was usually picked by November 15th.

Since the arrival of the boll weevil there is no more late crop, or, as it is called by the farmers, "top crop," for all the young bolls maturing

during the latter part of the season are usually destroyed by the weevil. The "bottom crop," consisting of the bolls which mature early in the season, and which thus escape destruction by the weevil, opens about the same time and most of it is usually picked before frost.

The Picking Process. — Picking may be done in two ways, either by machinery or by hand. The machinery is rather a recent development, and as yet an entirely satisfactory picker has not been produced. The greatest objection to those already on the market is the fact that even under the very best of conditions considerable amounts of trash, leaves, and other foreign matter get into the cotton.

Picking by hand is done principally by negroes. During the picking season negroes of all ages and of both sexes may be seen in the fields. They pick about 100 to 500 pounds of seed cotton a day, or an average of 175 to 225 pounds. When special inducements were offered, or when conditions were very favorable for picking, extremely large quantities



FIG. 70. — Men, women, and children are employed to pick the cotton. (Photograph by Eugene J. Hall, Oak Park, Illinois.)

have been picked in one day. The seed cotton is taken from the bur with the fingers and deposited in a sack. In the East this sack is swung from the shoulders and the entire quantity of cotton picked is carried bodily by the picker down the row until his sack is full. In the West

larger sacks are used, and the weight of the sack and its contents rests upon the ground and is dragged down the row as the picking process continues. This saves the picker considerably more energy than when it is toted. When the bags are full they are weighed and the weight and name of the picker recorded by the overseer. The bags are either emptied directly into a wagon, or the cotton is deposited in large baskets which are later emptied into the wagon. As soon as the wagon is full, in the East, it is carried to some place of cover where it is stored to await the time when all the cotton has been picked and can be carried to the gin at one time. In the West, it is hauled directly from the field to the gin.

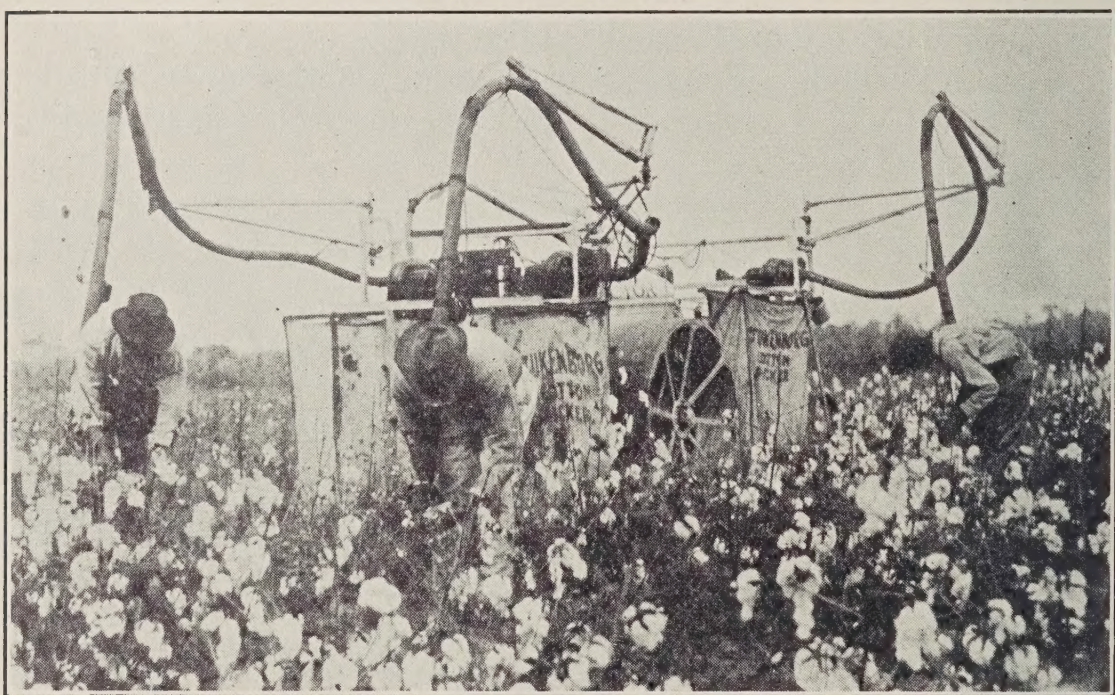


FIG. 71. — A view of the electric cotton picker invented by L. C. Stuckenberg, of Memphis, Tennessee. (Photograph by Underwood & Underwood, New York.)

As much trash and stained cotton as possible should be kept out of the main crop. These materials lower the grade of the entire cotton crop if mixed with it. Stained cotton, or cotton that has become dirty from being in contact with the soil, should be picked separately or not picked at all. At least three pickings are usually made. A picking should be made as soon as there are enough bolls open to justify it. Clean, bright cotton brings better prices than cotton that has been allowed to stay out and become tinged or discolored by the weather. This difference is more than enough to justify an extra picking. Some farmers consider a picking justifiable if there is an average of four or more bolls open per plant. However, it may be best not to pick cotton

too green for the lint continues to increase in length even after the boll is open until the seed dries. Cotton should not be picked when wet, as this may decrease the value of the fiber.

Yield of Cotton. — The average yield per acre of lint cotton for most sections ranges from 100 to 200 pounds. The average for the Cotton Belt for the year 1924 was 169 pounds. In localities where large applications of fertilizer is the practice, the average yields are higher than where no fertilizers are used. The average yield per acre is the highest on farms which are owned by white owners, these being followed by farms run by white tenants, followed by farms run by negro tenants, and is lowest on farms owned by negro owners.

The yield of cotton is affected largely by the quantity of fertilizers used, the fertility of the land, and the amount of cultivation it receives. Since 1896 the total application of fertilizers per acre in the Southeastern states has increased, as also has the average yield of cotton per acre. In fact, the increase in the total output of cotton in the Southeastern states due to the larger amounts of fertilizers and better cultivation was for a time more than enough to balance the decline in production in our Southwestern states caused by the boll weevil.

The following table shows the cost of producing cotton in 1923, as revealed by 2519 reports received by the United States Department of Agriculture, and tabulated on the basis of yield per acre.

HARVESTING OF COTTON

Yield groups (pounds lint per acre)	Number of reports	Acres in cotton per farm	Yield per acre. (Pounds of lint)	Cost per acre									Net cost of lint		Value of lint	
				Prepare and plant	Cultivate	Harvest and market	Misc. labor	Fertilizer and manure	Seed	Ginning	Land rent	Misc. costs	Total	Less value of cotton- seed per acre	Per acre	Per pound
20 pounds and under.....	32	55	14	3.60	5.25	\$ 2.11	\$0.70	\$ 2.94	\$1.14	\$0.22	\$ 3.52	\$1.52	\$21.09	\$ 0.74	\$ 4.28	\$1.45
21 to 60 pounds.....	249	69	44	3.84	5.24	3.98	.79	4.25	1.25	.59	4.33	2.69	26.96	2.10	13.32	.56
61 to 100 pounds.....	451	55	89	3.91	5.73	5.57	.79	3.97	1.16	1.33	4.88	2.57	29.91	3.60	26.55	.30
101 to 140 pounds.....	407	54	124	4.25	6.12	6.69	1.03	3.39	1.24	1.76	4.98	3.06	32.52	5.13	36.48	.30
141 to 180 pounds.....	394	70	161	4.18	5.92	7.60	1.11	3.55	1.22	1.99	5.99	2.74	34.30	6.79	47.73	.30
181 to 220 pounds.....	279	51	200	4.37	6.20	8.74	1.36	4.48	1.18	2.23	6.90	3.31	38.77	7.64	60.29	.30
221 to 260 pounds.....	257	63	245	4.71	6.59	9.85	1.56	5.04	1.40	2.77	7.08	3.33	42.33	9.71	72.60	.30
261 to 300 pounds.....	165	30	290	5.01	7.08	11.13	1.64	6.27	1.54	3.08	8.05	3.44	47.24	11.00	87.77	.30
301 to 340 pounds.....	34	56	324	5.26	8.51	13.39	2.46	9.03	1.64	3.32	9.59	5.09	58.29	12.64	95.34	.30
341 to 380 pounds.....	54	33	356	5.50	7.18	12.13	2.83	8.75	1.48	3.90	9.53	4.10	55.40	12.62	107.14	.31
381 to 420 pounds.....	94	31	401	5.71	8.62	13.74	2.37	10.41	1.51	3.71	8.91	4.37	59.35	14.98	124.22	.31
421 to 460 pounds.....	27	31	444	5.82	8.14	14.87	2.91	9.99	1.59	4.46	12.42	4.56	64.76	14.53	132.63	.31
441 to 500 pounds.....	60	26	495	6.09	7.75	17.71	3.04	9.73	1.55	5.17	10.43	5.54	67.10	17.94	150.42	.30
501 pounds and over.....	16	27	618	6.34	7.51	28.28	2.79	13.86	1.44	6.92	10.70	5.07	83.00	26.17	197.45	.32

CHAPTER XIII

GINNING AND BALING OF COTTON

Ginning Practices. — Before the invention of the cotton gin by Eli Whitney in 1792, the separation of the lint from the seed was a very tedious matter. An average man can separate by hand only one pound of lint a day. Today ginning is rather a simple process and will never again be a limiting factor in cotton production. Most farmers pay for



FIG. 72. — Farmers awaiting their turn at a ginnery.

having the cotton ginned, although in a few cases they may own their own gins. In the West the farmer usually hauls his cotton from the field to the gin, while in the East seldom any part of the cotton is ginned until a considerable portion of the entire crop is ready to be hauled at the same time. The seed from the ginned cotton may be taken back to the farm by the farmer to be sold later, or it may be sold to the

ginner. The entire charge for ginning and baling a 500-pound bale of Upland cotton ranges in price from \$1.50 to \$5.00. As it takes more time to run a roller gin, the charges for ginning and baling Sea Island and American-Egyptian cotton range around \$14.00.

Precautions Preparatory to Ginning. — In order that there may be no breaking of fibers or crushing of seed in the ginning process, the cotton should be dry before being put into the gin, the right kind of gin should be used, and the speed of the gin should be regulated so that it will not be too rapid. Farmers should insist that the ginneries be equipped with good machinery before they allow their cotton to be ginned. Poor machinery used in ginning increases the amount of linters and decreases the amount of lint.

Types of Ginneries. — There are two types of ginneries: (1) one-story ginneries; and (2) two-story ginneries. The fire risk is not so great with one-story buildings, and of course, the insurance is less. Also, the vibration is less with the one-story buildings, and consequently less wear and tear on the machinery. Good, substantial, fireproof two-story ginneries can be built, however.

Types of Cotton Gins. — The kind of gin used will depend upon the kind of cotton to be ginned. There are two types of cotton gins. First, we have what is known as the saw gin, the principle of which is the same as the gin first invented by Eli Whitney. The cotton is fed into a hopper, one side of which is a grate or grid. Through this grid a number of thin steel saws revolve. These saws are usually 10 or 12 inches in diameter, and number from 40 to 80. The teeth of the saws, as they revolve, catch in the fiber and pull the fiber from the seeds, as the grids are so set that the seeds cannot be pulled through. The saws are cleaned of the ginned fiber by revolving brushes. The saw gin can be used satisfactorily to gin Upland cotton, both the long and the short staple. This gin cannot be used to gin Sea Island and American-Egyptian cotton for it breaks their long fibers. Even a small percentage of the fibers of the Upland cotton is broken under the best of conditions, and the percentage may be greatly increased if the gin is run too rapidly, or if the cotton is fed too fast, or if the cotton is not dry when ginned.

Second, we have the roller gin, which is used in ginning Sea Island and American-Egyptian cotton. The roller gin was brought into this country in 1772. It has been used from a very early date by the Hindoos and Chinese. The Macarthy type of roller gin is used in the United States. The cotton is usually fed from a table to a leather (preferably walrus hide) covered roll, the surface of which is roughened so that the fibers adhere to it. A vibrating, or in some cases a revolving, steel knife is so set against the roll that the seed cannot pass between the

knife and the roll as the roll revolves toward the knife. In this way the lint passes under the knife and the seed are knocked off by the rapidly vibrating blade. The delinted seed fall through a grid and the lint is removed from the roll on the other side of the knife by a revolving brush. The roller gin separates very nicely the Sea Island and American-Egyptian cotton, but it must be run slowly. This makes the amount of cotton turned out per hour 60 to 80 pounds, which is very small when compared with the quantity of Upland cotton ginned per hour by the saw gin. This greater time demanded in ginning 500 pounds of Sea Island or American-Egyptian cotton, as compared with the time required in ginning 500 pounds of Upland, results in the greater charges for ginning the long staples.



FIG. 73. — Cotton bales lying in field around wooden shed. (Courtesy, U. S. Dept. of Agriculture.)

At one time there was a movement started to operate traveling gins which were owned by individual corporations, or coöperatively among the farmers, just as some threshing machines are owned today. However, this never proved successful, one of the chief objections being the lack of sufficient power and equipment which must always be at hand. Since that time stationary gins have been started in every community, and have proven a great success.

Handling of Cotton at the Ginney. — Farmers usually convey their seed cotton to the gin in high-bodied, one-horse or two-horse wagons.

A two-horse wagon will hold about 1500 pounds, which when ginned will produce about a bale of lint. In the better types of ginneries the seed cotton is removed from the farmer's wagon by air suction tubes which convey it to the feeder, which in turn feeds it evenly to the gin. As the seed cotton is separated the seed falls into a trough and from

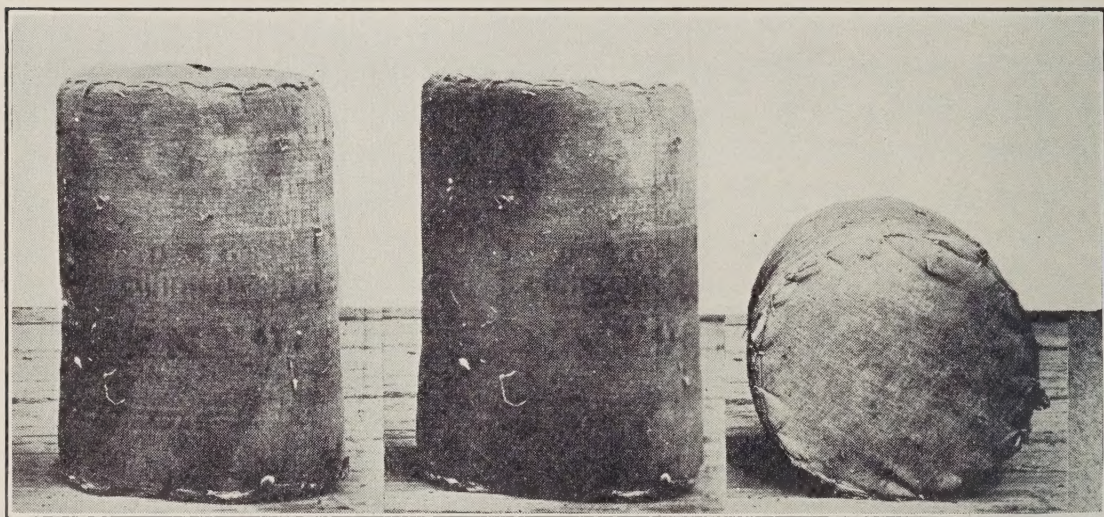


FIG. 74. — Round bale, side and end view, density 28 lbs. per cubic foot, approximate dimensions 35 by 20 inches (diameter). (Courtesy, U. S. Dept. of Agriculture.)

there is carried by a screw conveyor to the seed bin. The lint passes from the gin, through a lint flue, to the condensor, which gives it its final cleaning, smooths it out into a bat or sheet, and drops it in regular layers into the press box, where it is pressed by great pressure into bales.

Cotton Bales. — When the lint has been separated from the seed it is pressed into bales of different sizes. The American-Egyptian and the Upland cottons are compressed in a box 54 inches long, 27 inches wide, and about 45 inches deep. This gives what is called the standard flat bale, which weighs about 500 pounds. Iron bands and a covering of coarse bagging on two sides and the ends hold the cotton together. The weight of this covering material amounts to about six per cent of the weight of the bale, or 30 pounds, and is spoken of as tare. The standard bale should weigh 500 pounds and have a density of 12 to 15 pounds. It should be covered with light, closely woven Hessian cloth, and be secured with narrow, light steel bands which are prevented from slipping by studs or other suitable means. The tare should not exceed 30 pounds. In some sections, particularly the West, round bales are made which are about 35 inches long and about 22 inches in diameter, and weigh about 250 pounds. The cotton in these round bales is completely protected by bagging. The round bale is preferred by many,

not only because the cotton is protected from outside deteriorating influences to which the bale may be subjected, but also because of its ease in handling.

In Georgia and Florida Sea Island cotton is put up in bales 54 by 26 inches, weighing about 400 pounds, while in South Carolina it is put up in bags $7\frac{1}{2}$ feet long by $2\frac{1}{2}$ feet in diameter, weighing about 350 pounds when full.



FIG. 75. — Flat or uncompressed bale, side, and end views, density 10 to 15 pounds per cubic foot, approximate dimensions 54 by 27 by 48 inches. (Courtesy, U. S. Dept. of Agriculture.)

The round bales have a higher density than the flat bales. In fact, the flat bales have a comparatively low density. Where long shipments are to be made, and cargo space must be considered, these bales are compressed still farther by gin-compressors. During the World War the bales for export were compressed to 32 to 36 pounds per cubic foot. The new hydro-electric compresses, where only 450 total tons pressure is applied, are far superior to the old compresses where 2000 to 2500 tons were required to secure a bale that would finally have a density of 22 to 40 pounds. These gin-compressors are usually located at concentration points. Spinners object to the compressing of Sea Island cotton, for they claim that it injures the fiber. For this reason Sea Island cotton is seldom compressed.

Recent work by Meadows and Blair has shown that compressing cotton to standard or high density when in a dry condition is not injurious to its spinning value, whereas compressing wet cotton to high

density increases the percentage of waste or reduces the breaking strength of the yarn, or may do both.

Plated Bales. — There was a practice in the past among a certain group of farmers to plate their bales; that is, put poor cotton lint in the center of bales, and long fiber of good quality near the outside. In this



FIG. 76. — Gin compressed bales. (Courtesy, U. S. Dept. of Agriculture.)

way when the bale was sampled the sample misrepresented the contents of the bale. Such a practice cannot be condemned too strongly. The farmer or the community that practices such a method of trading never gains therefrom but always loses in the end.

Number of Cotton Ginneries in the United States. — The number of cotton ginneries in the United States has grown as cotton production has increased, until in 1914 there were 24,547 active ginneries in the Cotton Belt, which averaged 648 bales ginned each. Since 1914 there has been a marked decrease in the number of active ginneries, until in 1924 there were only 15,478.

REFERENCES

1. Cotton production and distribution. Dept. of Commerce, Bur. of Census, Annual Bulletins.
2. Taylor, Fred, Griffith, D. C., and Atkinson, C. E. Cotton ginning information for farmers. U. S. D. A., Farmers' Bul. 764, 1916.

CHAPTER XIV

WAREHOUSING OF COTTON

The problem of housing and storing of cotton comes into play as soon as the cotton is ginned. Many farmers allow their cotton to remain outside, exposed to the weather. The action of the weather turns the fiber yellow and decreases its strength. This damage is called "country damage." It should be remembered that good cotton may get into a bad condition, but that bad cotton cannot get into a good condition. The farmers of the Cotton Belt are not in ignorance as to the decrease in value caused by weathering, and yet hundreds of thousands of dollars are lost each year by the cotton growers through this course alone.

Sooner or later the cotton is sold to the middleman, who usually has it shipped to the concentration points, where it is finally stored in warehouses. In some cases, particularly in the East, the grower stores his bales as soon as they are ginned, in neighboring warehouses. The charges for storing are nominal and the grower not only has his cotton protected from the weathering agents, but he has it in a position where it can act as security for borrowing money. In a number of cases the warehouses hold federal licenses and a receipt from such a warehouse will be recognized as good security by any banking organization which is a member of the Federal Reserve Banking system. In the West the cotton is usually sold just as soon as it is ginned, so that warehouses are found principally at the concentration points.

Cotton keeps better in storage than any other farm product, and even when exposed to the elements resists decay to a marked extent. This, together with the fact that the farmer is opposed to storage, as a general thing, especially if he has to pay a charge for the storage, makes it difficult to inaugurate throughout the South a system of reform combating such evils as damage to cotton from exposure.

The Value of Cotton Stored in Warehouses. — As has already been said, nearly all banks are willing to advance money on cotton at liberal terms if the cotton is properly stored and insured. In fact, they prefer it to real estate, and will accept it as collateral as readily as government bonds. However, in cases of emergencies, when cotton is bringing a very low price, and a large number of cotton growers are asking for loans, the capital at the disposal of the banks is not sufficient to supply the demand. This weakness in our banking system will have to be

corrected before the building of many more warehouses for farmers' use is undertaken.

The Warehouse Capacity of the Cotton Belt. — The total storage capacity of the warehouses of the entire Cotton Belt is ample to store every bale of an average crop. Virginia and Florida have a storage capacity far greater than their average annual production. Georgia has a greater number of warehouses than any other state, and a storage capacity somewhat larger than its average annual production. South Carolina, Mississippi, and Oklahoma have a storage capacity slightly in excess of their average annual production. Arkansas, North Carolina, and Texas have a storage capacity less than their average annual production.

The Distribution of Cotton Warehouses. — While the storage facilities of the South are more than sufficient to store every bale of an average crop, yet the distribution is very un-uniform. Georgia has a better distribution of warehouses than any other state, but even this distribution could be greatly improved upon. In a large number of communities storage facilities are not available for the use of the farmer, and the farmer must either hold his cotton on the farm or ship it to a cotton factor in one of the larger towns. Even in many of the primary markets there are no storage facilities whatsoever. In such markets cotton remains on the ground, in public yards, and about supply stores for weeks at a time. In some states a large portion of the warehouse facilities is congregated at some distant market and is unavailable for the use of the farmer. For instance, one-half of the storage capacity of Texas is found at Galveston and Houston. Furthermore, most of the best warehouses belong to the cotton mills and to the cotton factors, or middlemen. In a majority of cases these warehouses are unavailable for the farmer's use.

Standard Warehouses. — The buildings which act as cotton warehouses throughout the South are of many sizes and made from many materials, — concrete, brick, corrugated iron, and wood may be used in their construction. Farmers erecting coöperative warehouses should keep in mind that it will always pay to erect and properly equip modern warehouses conforming to the standards promulgated and recommended by the underwriters' associations. These are called "standard warehouses." Such warehouses should always be equipped with automatic sprinklers and other devices that are recommended by the underwriters' associations. If this is done, the insurance rates will not be so high, and a saving will be made in the long run.

Size of Warehouses. — The size of the average warehouse depends upon many factors, principal among which may be mentioned the public

demand for storage in that vicinity. The large, advantageously located, and properly organized warehouses always pay better than the small warehouses. In fact, the smaller warehouses are often operated at a loss.

Service Rendered to Farmers by Warehouse Corporations. — The service rendered to the farmers by most of the companies operating public warehouses is poor, and the charge is usually high. This is due, no doubt, to the small amount of business done. As a matter of fact, the farmers' business is undesirable because of the small lots of cotton that must be handled. As has been cited elsewhere, the better warehouses are not available for the farmers' use, being owned by mills and middlemen. The need of inauguration of good systems of warehousing is very great throughout the South. If warehouses were available for the use of the farmers many of them would stop depressing the price of cotton by selling their cotton just as soon as ginned, in years when the price is low.

CHAPTER XV

MARKETING AND TRANSPORTATION OF COTTON

There was a time when the entire cotton crop was grown to be used on the plantation. Today it is grown to be marketed, and in most sections it is the principal money crop. At one period in the history of the cotton plant the seed were considered valueless and were thrown away. Later their use as a fertilizer became recognized, and after the



FIG. 77. — A farmer selling two bales of cotton to a cotton dealer.

lint was sold the seed were returned to the land. Today, however, both the lint and the seed are sold, and in some exceptional cases even the stalks and the roots, the stalks being used in the manufacture of a coarse fiber, and a certain chemical similar to that found in ergot of rye being extracted from the roots.

Route from Farm to Spinner. — There is usually a tortuous course from the cotton farmer to the producer of cotton goods. Cotton goods

may be manufactured within a few miles of the cotton plantation and delivered to the consumer, also within a few miles of the cotton mill. Again, the raw fiber may be carried to another part of the world to be manufactured, and delivered to the consumer in still another part. This course will be determined somewhat by the methods of trading followed, the means of transportation, the section of the world where the cotton is grown, etc.

Cotton Prices. — Price is a very fluctuating thing, and is governed by many factors, among which staple and grade are probably the most important. Of course, the price the farmer receives for his crop is governed also by supply and demand, just as the price of any other crop is so regulated. The business sense exercised in the selling of the crop by the farmer is also a factor of no meager importance.



FIG. 78. — Ordinary compressed cotton bales ready for export, showing patches of coarse bagging bound on to cover sample holes and to increase tare. (Courtesy U. S. Dept. of Agriculture.)

The Selling of Seed Cotton. — The cotton crop is not marketed as seed cotton to any extent except in the regions where cotton is not extensively grown, with the exception of certain sections in the Sea Island cotton growing region. In such localities it is a ready cash crop for any amount which is for sale. The only advantage of selling seed cotton in the major cotton regions of the Cotton Belt is to save the time of men who wait at the ginneries while the cotton is being ginned.

When seed cotton is bought, very little attention is paid to grade of

the staple. The price usually offered by the buyer depends upon the current prices paid for lint and seed, and the average percentage of lint, seed and trash content found in the average seed cotton of the community.

In most cases the farmer loses by selling his crop in this way, and the practice in most sections is to be condemned.

The Selling of Seed and Lint. — Seed is sold when the cotton is ginned, the ginner allowing sixty to sixty-six pounds for every hundred pounds of seed cotton. After ginning the bales may be sold at once, or they may be hauled back to the farm to await a rise in the market. When the farmer does sell his lint he may sell directly to the buyer for the textile mills, or to a middleman, or to any of the many classes of cotton dealers. Quite often, especially among the negroes, the cotton is turned in to the country store dealers in whole or part payment for loans, or for fertilizers sold on credit. In such cases the ignorant farmer is at the mercy of, and often is defrauded by, unscrupulous dealers.

Shipping. — The cotton, having been bought by the dealers, is sooner or later set in motion on its course to the manufacturer. Each community or section has its centers at which all cotton is collected and stored away in immense warehouses. Here it is sampled, typed, graded, classed, marked, and, if need be, compressed. From these centers the cotton is moved, as rapidly as necessary, and is transported directly to the textile mills. The final destination of the cotton may be to mills of any part of the world. Some of it is transported to mills in the vicinity where it was grown, some to the mills of the New England States, some to England, France, Germany, or other portions of Europe, and some even to China and Japan. Most of the cotton grown in the South Atlantic States is sent to the mills in those states. Foreign countries send more gold into the United States in payment for our cotton than for any other American crop.

Size and Density of Bales. — The standard bale has a density of about twelve to fifteen pounds to the cubic foot. If the final destination of the cotton is a nearby mill, the bales are loaded into a box car just as they are and sent direct. A thirty-six-foot box car holds about thirty to thirty-five bales. However, if the cotton is destined for some distant mill in this country or to foreign mills, the bales must be compressed in order to save freight charges. The railroads have two freight rates, one for compressed, and one for non-compressed cotton. In a number of the markets, where there are no facilities for compressing, the railroads own compresses and will compress the standard bale to a density of about twenty-two to twenty-four pounds. About fifteen cents a hundred is the usual price charged for compressing by the rail-

roads, although extra charges are made for any patching of the burlap that is necessary. When this compressing is done from sixty-five to seventy-five bales can be loaded into a thirty-six-foot car, thus cutting materially the freight rates. In some parts of the country the cotton is put up in round bales of thirty-two to thirty-seven pounds per cubic foot. Two hundred such bales can be loaded into a car, which is about



FIG. 79. — Railroad compress at Shreveport, Louisiana, showing cotton bales on end in foreground and placed "on range" for sampling on platform. (Courtesy, U. S. Dept. of Agriculture.)

equal to one hundred standard bales. Non-compressed cotton arriving at the seaports such as Mobile, New Orleans, Galveston, and Savannah, billed for foreign markets, is compressed to a density of thirty-five pounds per cubic foot, which results in a still further saving of cargo space.

Amount of Cotton Exported. — By far the greater portion of the cotton grown in the United States is exported. Fifty-four and one-half per cent of the average annual production for the five-year period from 1919 to 1923 inclusive was exported.

Cotton Markets. — Cotton, just as corn, wheat, oats, barley, and rye, passes through a more or less complicated system of markets from the producer to the consumer. The term market is used in this case to designate a place where men meet to sell and buy. In some cases cotton is sold and bought a number of times even before the fiber reaches the mill, while in other cases the cotton may be sold by the grower directly to a representative of the mill.

Kinds of Markets. — There are two kinds of markets, one of which is known as a “spot market,” and the other as a “future market.” A spot market is a market dealing in spot cotton. By spot cotton we mean that actual cotton exists in the market. Cotton may be sold and bought as actual cotton, or contracts for future deliveries may be dealt in. A future market is a market dealing in futures.



FIG. 80. — Railroad compressed bale showing top end and side views, density 20 to 28 pounds per cubic foot, approximate dimensions 56 by 28 by 18 inches. (Courtesy, U. S. Dept. of Agriculture.)

The spot markets may be divided into four classes: (1) primary markets, — the villages and towns in which the cotton is first sold by the farmer; (2) interior markets, — the larger towns and cities in which the cotton of a locality is centralized and standardized and finally shipped in large lots to the manufacturer; (3) export markets, — usually the seaport cities from which the cotton is shipped to foreign countries; (4) consuming markets, — the manufacturing towns or cities to which the cotton is shipped for manufacture.

There are three future cotton exchanges in the United States — New York, New Orleans, and Chicago. New Orleans is both a spot and a future market.

Some European markets, such as Liverpool, Bremen, and Havre, also deal in American cotton.

All markets are more or less closely connected. The future markets stand at the top of the system, and they determine the prices in all the

other markets. Dealing in futures helps to stabilize prices, although there is an element of speculation present which is undesirable but which cannot be eliminated.



FIG. 81. — High density bale, top, side, and end views, density 28 to 40 pounds per cubic foot, approximate dimensions 59 by 24 by 19 inches. (Courtesy, U. S. Dept. of Agriculture.)

Time of Buying and Selling. — As soon as ginning commences, buyers are on hand and dealing in spot cotton begins. A large portion of the crop is usually sold just as soon as ginned. This is due to the fact that many growers either wish to sell and get their cotton off their hands at once, or they are so situated financially that they are compelled to sell. Other growers hold their cotton and sell late in the season. In order to eliminate as much as possible the luck of selling just when the market is at its height, some growers sell one-half of their cotton just after ginning and one-half later in the season. The price received by the grower is based upon the quotations for middling on the future markets, the grade of the cotton for sale, the location of the market, and with the uneducated grower, upon his power of bargaining with the dealer.

Spinners do not as a general thing carry on hand large quantities of cotton at any one time. They usually buy off and on during the year

on the market from cotton dealers, although in some cases, as has already been cited, they may buy directly from the farmers on the primary markets. Spinners always buy their Sea Island cotton either directly from the farmers or from local dealers in the Sea Island cotton growing district.

REFERENCES

1. Creswell, Charles F. Disadvantages of selling cotton in the seed. U. S. D. A., Bul. 375, 1916.
2. Taylor, Fred. Relation between primary market prices and crops of cotton. U. S. D. A., Bul. 457, 1916.

CHAPTER XVI

GRADING AND CLASSIFICATION OF AMERICAN UPLAND COTTON LINT

Cotton, as it is usually put on the market, is a very un-uniform material. Because of this fact it is always necessary that the cotton be classified into groups or separates of a similar uniformity. This characteristic un-uniformity is due to the fact that since cotton has been introduced into the Cotton Belt there have arisen a large number of varieties that may differ among themselves in color, strength, length, maturity, and character of fiber. Environmental factors, such as the climate, the soil, and the season, as well as the care taken of the fiber before and after baling, likewise help to produce to some extent these un-uniform characteristics.

Some kind of classifying has been made by the buyer ever since cotton was first marketed. These groups, or separates, of cotton of similar uniformity made by the buyer were, and are now, called grades. However, the methods of grading formerly practiced by the buyer were not always satisfactory. Each buyer had his own idea as to the value of the particular cotton offered for sale. Even the buyers of the same market would frequently give different valuations to the same cotton. This being true, it naturally followed that no two markets would offer the same price to the farmer for his cotton, and it became a pure game of chance, other things being equal.

In the past the grower did not undertake to grade his cotton. In fact, the average grower knew nothing, and pretended to know nothing, concerning the particular uses to which his cotton was best adapted. As a general thing he accepted the value set by the dealer and said nothing more about it. If a low price was given him because of a low grade of cotton he rarely recognized the source of the trouble, and hence did not know how to remedy it. Besides, even if he did, there was no incentive to better the grade of cotton he sold, for it was a chance as to just how his cotton would be graded the next time.

For these reasons in 1909 the United States Department of Agriculture undertook to correct the situation by establishing definite and specific grades of the Upland cotton, grades that could be used in aiding in determining the comparative value of different qualities as well as to furnish a basis for describing cotton so as to make buying and selling

more satisfactory when samples could not be had. In December of 1914 the results of these investigations were given to the public. These grades, which are now known as the Official Cotton Standards of the United States, were not forced upon the cotton dealers, although they were urged to accept them. At the same time the United States Department of Agriculture furnished the county farm agents with practical forms of Official Standards in order that the growers might have access to them. Since that time a majority of the dealers have adopted the standards. Also from time to time necessary changes in the system of classification have been made which culminated in 1924 with an agreement with foreign buyers whereby certain modifications were made and an alternative name, Universal Standards, sanctioned. Largely through the efficient work of the county agents the growers have been brought to see the advantage of knowing something concerning the grading of at least the most common of the grades found on the market. This, together with the introduction of standard grades, has aided materially in bringing about not only a fairer basis of trading, but a stimulus to the production of a better grade of cotton.

The grades and qualities of cotton are so varied that it requires a number of months of experience, even with the help of the Official Cotton Standards, to become expert in grading. However, the most common grades found on the market, such as Good Middling, Middling, and Low Middling, at least, should be familiar to all growers.

The Official Cotton Standards of the United States depend upon the classification of cotton as to grade, length, and character of staple.

Classification According to Grade. — There are three factors which determine the grade of cotton: first, the color, luster, and brightness of the fiber; second, foreign material that has become mixed with the fiber during the process of picking, handling, and ginning; third, the extent to which the fiber has been hurt during the process of ginning, or the quality of the ginning.

The methods and names used in classifying and naming grades of cotton by the Official Cotton Standards is somewhat different from those formerly used by the trade. The Official Cotton Standards recognizes the following major divisions of white, spotted, tinged, light stained, yellow stained, gray, and blue stained cottons. (See page 167.)

It will be observed that in the case of white cotton there are nine grades, and that the grade Middling, as the name implies, is the middle grade. This is the basic grade upon which the market quotations of all short staple cottons are based. Grades I to IV, inclusive, bring a higher price than that quoted for Middling, and grades VI to IX, inclusive, bring a lower price. It is very probable that sometime in the near future

the grade names will be done away with and the present synonymous grade numbers used altogether.

GRADES AND COLORS OF THE UNIVERSAL STANDARDS FOR AMERICAN UPLAND COTTON

Blue stained	Gray	Standards for grades of Upland cotton, white*	Spotted	Yellow tinged	Light stained	Yellow stained
.....	.....	1 or M.F.	.....	.....	.....	.....
.....	.....	2 or S.G.M.	.....	2 T	.....	.....
3 B	3 G	3 or G.M.	3 Sp.	3 T	3 L.S.	3 S.
4 B	4 G	4 or S.M.	4 Sp.	4 T	4 L.S.	4 S.
5 B	5 G	5 or M.	5 Sp.	5 T	5 L.S.	5 S.
.....	.....	6 or S.L.M.	6 Sp.	6 T	.....	.....
.....	.....	7 or L.M.	7 Sp.	7 T	.....	.....
.....	.....	8 or S.G.O.	.....	.....	.....	.....
.....	.....	9 or G.O.	.....	.....	.....	.....

Practical forms of the Official Cotton Standards are prepared for Blue Stained, White, Yellow Tinged, and Yellow Stained divisions.

* M. F., Middling Fair; S. G. M., Strict Good Middling; G. M., Good Middling; S. M., Strict Middling; M., Middling; S. L. M., Strict Low Middling; L. M., Low Middling; S. G. O., Strict Good Ordinary; G. O., Good Ordinary.

The Official Cotton Standards require Strict Good Middling, or above, to have a bright white or creamy color, absolutely free from any discoloration. No definite or fixed color is absolutely required in grades below Strict Good Middling. They may be creamy, "dead white," grayish, dingy, or what not, and any or all of these shades may be found in any grade below Strict Good Middling.

It is estimated that one-fifth of the American cotton crop falls within the above standards for tinged or stained cotton. Each of the color standards now contains approximately the same amount of foreign material as the corresponding grade of the white standard.

There are several factors which enter into the determination of color. The color, particularly among the lower grades, is usually determined by the same factors that cause the lowering of the grades for other reasons. Cotton which is picked in localities where little rain falls during the picking season always has a brighter, cleaner look than cotton from localities where a heavy rainfall during the harvesting period is prevalent. The first pickings in any locality are always of a brighter

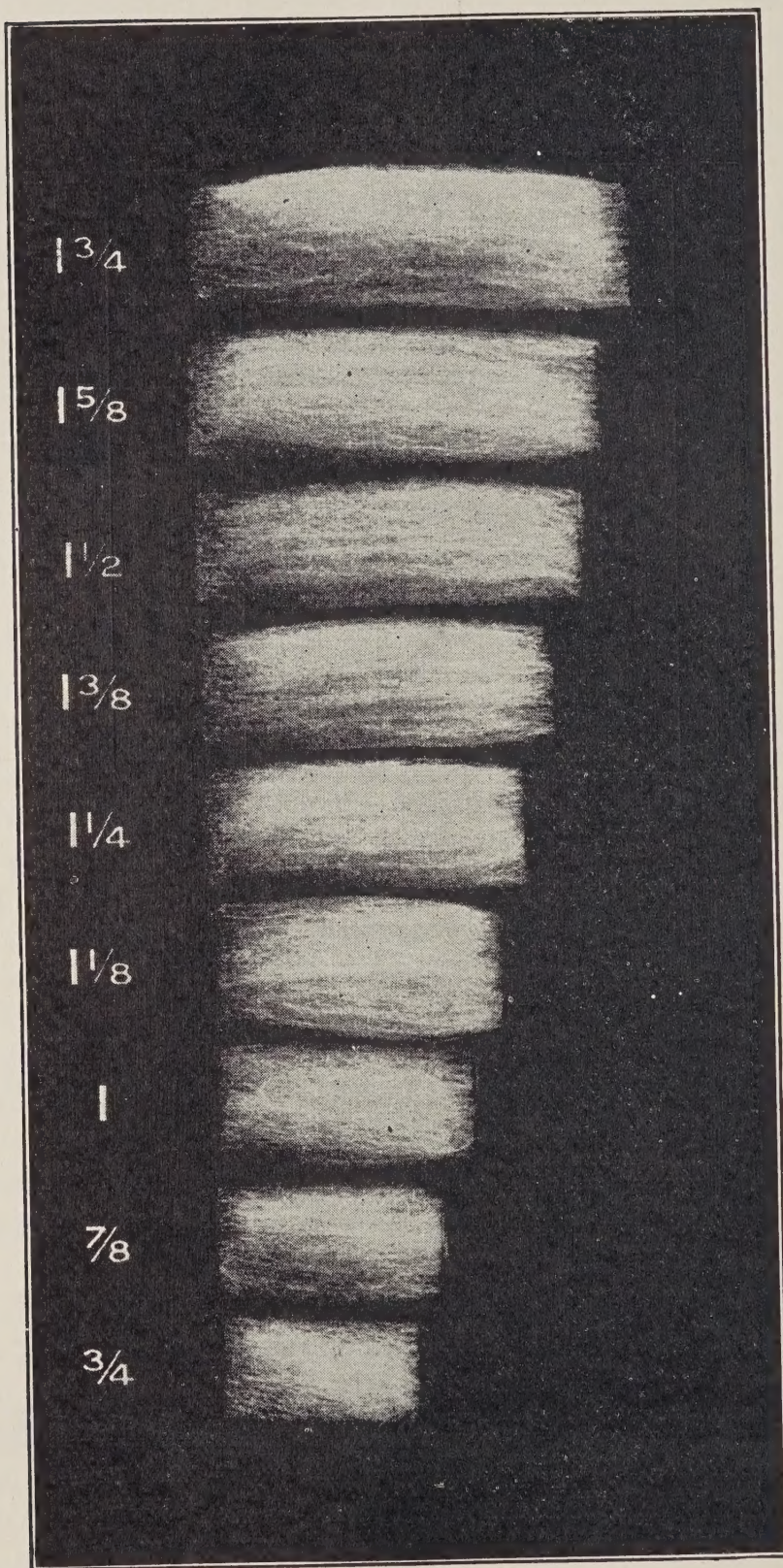


FIG. 82. — A photographic representation of the official cotton standards of the United States of those lengths of staple for which types are available for distribution, each respective length as shown being obtained from the original type bale. (Courtesy, U. S. Dept. of Agriculture.)

color than the later pickings. The action of frost on the late bolls before they open produces a discoloration. Cotton left in the bolls for any length of time before picking becomes discolored from the dead vegetation with which it may be in contact. The lint of the bolls near the ground often becomes stained with soil during rains. Especially is this discoloration noted where cotton is grown on red soils. Where cotton is continually exposed to an excess of rain, either while in the boll, or after it is ginned, it becomes stained a bluish cast by a certain mildew. The American farmer has a very costly custom of leaving his bales unprotected to the weather from the time it is baled until he sells. This is one of the evils of cotton production which is being combated most energetically by all the agricultural institutions of the South, and which will amount to hundreds of thousands of dollars of saving each year if it can be corrected.

Under the very best of conditions of growth and handling, the cotton fiber will become mixed with more or less foreign material. When this cotton reaches the mill the foreign material must be separated from it. This means that extra labor and expense must be expended before the cotton is put out as a finished product. The spinner does not stand for this extra expense, but charges it up against the cotton when it is bought. Thus we find that low grade cotton contains the greatest, and high grade cotton the lowest amount of foreign material, and that low grade cotton brings the lowest price and high grade cotton the highest price.

This foreign material may be divided into three groups: (1) dust, dirt, and sand; (2) broken pieces of the cotton leaves and bracts; (3) motes and cut seed.

Most of the lower grades of cotton carry varying amounts of dust, dirt, and sand, the quantity present being dependent upon the weather conditions during the period of harvesting. These materials always lower the grade to some extent. However, separate penalties are made other than that of grade if large quantities of such material are present.

If up-to-date machinery and methods of production are used, the greater part of these materials should be absent from the marketed cotton.

The quantity of leaf present also lowers the grade. Both weather conditions and care or carelessness in picking determine the amount of leaf present. Cotton picked before the plant is killed by frost will contain less leaf than cotton picked after the vegetation has been killed. Most of the leaf found in cotton is made up of parts of the leaf bracts that are found just at the base of the boll. When the boll opens these leaf bracts are often in direct contact with the cotton fiber. When

these bracts are killed by frost they dry up and become crisp and brittle, so that when the fiber is pulled from the burs they break into small pieces and become intimately mixed with the seed cotton.

The presence of motes and cut seed is due to two factors: first, the ginning of cotton with poor or worn-out gins which cut the cotton seed and then allow portions of these cut seed to pass on with the lint; second, the presence of immature seed in the seed cotton which may pass on with the lint without being ginned. The presence of either motes or cut seed always lowers the grade of the cotton.

The lint as it comes from the gin should be smooth and even, and free from all tangles. However, if it is poorly ginned it may contain neps and gin-cut staple, or it may be rough and stringy in appearance.

Neps are small white centers of matted fiber and can be seen readily when the lint is pulled out into thin layers and then held up to the light. They may be caused either by (1) dampness in the cotton when ginned; (2) the pressure of immature staple when ginned; (3) the feeding of seed cotton too fast in ginning, especially if a poor gin is used.

All saw gins cut the fiber to a greater or less extent. In fact, the introduction of an improved saw gin, or a gin of entirely different type which would not cut the fiber, would aid materially in the production of better cotton goods. When an excess number of cut fibers is present they give the lint a rough appearance. Such cotton is hard to grade, and formerly in order to be on the safe side the grader always graded it low enough to be sure it would not be turned down when it passed on to the next dealer. Thus, the grower, offering for sale cotton containing cut fibers, often found its grade lowered, not only because of cut fibers, but also as a means of safety on the part of the grader.

Stringy cotton is produced either through the ginning of wet or immature fibers, or through the bad adjustment of the gin. The fibers stick together in stringlike masses and are very hard to separate. When such cotton reaches the mill this stringy portion is separated in the cleaning processes and goes into the waste.

Classification According to Length of Staple. — Cotton whose fiber is less than one and one-eighth inches is called "short-staple" cotton, while all cotton whose staple runs over one and one-eighth inches is called "long-staple," or just "staple." Rather recently there has developed a tendency to call everything more than an inch in length staple cotton. The term *class* is used to designate both grade and staple.

Long-staple cotton is graded very much as is short-staple. In grading the long-staple, however, the grader is usually more lenient in cutting for neps, strings, and curls, etc., than he is in grading short-staple.

The long-staple is very much harder to gin because of its length, and a certain amount of unsmoothness is always present in the lint. Then, too, the length of staple in long-staple cotton is the basis of value, while grade assumes a place more or less in the background. This method of grading does not apply to the Sea Island and Arizona-Egyptian cottons.



FIG. 83. — Preparing the official cotton standards. (Courtesy, U. S. Dept. of Agriculture.)

Other factors being equal, there is very little difference in the market price of short-staple ranging from three-fourths to one inch in length. Yet, no doubt, the real value of one-inch staple over three-fourths-inch staple is about as great as one grade over another. The time may come when the length of short-staple will be a prominent factor entering into the financial value of the cotton, but just how soon this will be it is hard to say.

The United States Department of Agriculture, in Bureau of Markets Service and Regulatory Announcements No. 41, describes the method of “pulling the staple” as follows:

“Grasp in the two hands a tuft of cotton of a size convenient for the purpose (about $\frac{1}{4}$ of an ounce), holding it firmly between the thumb and forefinger of each hand, with the thumbs placed together, the fingers being turned in toward the palms of the hands, and the middle joints

of the second, third, and fourth fingers of each hand touching the corresponding joints of the fingers of the other hand, so as to give a good leverage for breaking the cotton.

“Pull the cotton slowly apart with about the same leverage of each hand on the joints of the fingers, separating the tuft of cotton into two parts.

“Discard the part remaining in the right hand.

“Grasp with the thumb and forefinger of the right hand, the end of the tuft of the cotton retained in the left. The point of pressure on the cotton in the left hand is just below the joint of the thumb and at the nail joint of the forefinger.

“With the right hand draw a layer of fibers from the cotton held in the left hand.

“Retain in the right hand the layer so drawn.

“Repeat this operation four or five times, placing each successive layer directly over the fibers previously drawn, using care to see that the ends of all the layers are even with each other between the thumb and forefinger of the right hand.

“After discarding the cotton in the left hand, hold the fibers thus obtained between the thumb and forefinger of the right hand and smooth them with the thumb and forefinger of the left hand.

“Place these fibers on a flat horizontal surface with a black background.

“Block off the ends of the fibers with a cotton stapling rule, so as to indicate the length of the bulk, or body, of the fibers.

“Then measure the distance between the blocked-off ends.”

Queer as it may seem, graders vary more in the determination of the length of a sample of cotton than they do in the determination of the grade. This is because all graders do not “pull” the sample in the same way. In the process of pulling one grader may discard more of the shorter or longer fibers than another, which causes the variation in the estimated length as given by different graders. If available standards of fiber 1, $1\frac{1}{16}$, $1\frac{1}{8}$ inches, etc., could be had by the graders to be used in comparison with the sample to be graded, these differences of opinion would be eliminated. However, this method has been tried out, but because of many objections, the principal one being the expense of furnishing the graders with samples, the procedure has not always proved feasible.

Classification According to Character. — The value of cotton is determined not only upon the grade, and strength of the fiber, but also upon the character. By character we mean the uniformity of staple, the strength, the body, the smoothness or silkiness of the fibers and the drag. The character of the lint varies from year to year, depending upon the season, soil, rainfall, and other environmental factors. Thus it appears impossible to set standards for character. Many commercial firms represent character to their clients by means of types.

The uniformity of the staple as to length is of considerable import to the manufacturer, as the amount of waste is dependent largely upon the presence of equal or unequal lengths of fiber. Cotton secured from sections where only one variety is grown is uniform in length, but the uniformity of cotton secured from sections where several varieties are grown on a small scale, or where the cotton grown is badly mixed, is poor. Some pure varieties produce un-uniform fibers; that is, the fibers growing at the base of the seed are longer than those growing on or near the apex.

The strength of the fiber is an exceedingly important factor, for, other things being equal, it is upon this characteristic that the strength of the manufactured yarn will depend. The strength of the fiber is influenced by soil, climate, season, variety, and maturity. The first and second pickings, made before the top crop opens, often give a better character of staple than later pickings. The staple of Good Ordinary and Low Middling is weaker, generally speaking, than is the staple of grades above Low Middling. The strength is lowered usually by the same factors that lower the grade. The actual strength depends upon the diameter of the fiber, and upon the part of the fiber selected. The fiber is strongest at the end nearest the seed, and weakest at the apex. Low grades of cotton usually contain a considerable amount of immature seed. Tinged and stained cotton are usually weaker than non-tinged or non-stained cotton. Cotton that has been picked from bolls that were forced open by frost, or that has been taken from bolls which were forced open by some mechanical means, also is made up of a considerable amount of immature cotton. Perished staple is a name given to the fiber of cotton whose strength has been reduced more or less through exposure either before ginning or after baling. Immature and perished staple are of low value for manufacturing purposes, as they produce large amounts of waste and weak yarn.

In the following table is given the comparative diameter and strength of some common cottons:

Cotton	Length	Diameter	Strength, grams
Sea Island.....	$1\frac{3}{8}$ – $2\frac{1}{4}$	.0004–.0006	100
Egyptian.....	$1\frac{3}{16}$ – $1\frac{1}{2}$	.0005–.0007	130
American Gulf.....	$1\frac{1}{16}$ – $1\frac{5}{16}$	.0004–.0007	140
Uplands.....	$\frac{3}{4}$ –1	.0006–.0007	140
Indian.....	$\frac{1}{2}$ – $1\frac{1}{8}$	.0007–.0009	150

Body refers to the relative density of the fibers. It is determined by the weight and fineness of a sample as well as the drag.

Drag is a name used to designate the resistance offered when a tuft of the sample is being pulled or broken. Heavy-bodied cottons are usually grown on fertile soils such as bottom land, while lighter-bodied cottons are produced on poor lands or under adverse conditions.

Smoothness or silkiness of the fibers is desired for the manufacture of fine goods. It is largely a varietal characteristic.

REFERENCES

1. Brand, Charles J. Service and Regulatory Announcements. U. S. D. A., Bur. of Markets, S. R. A. No. 41, 1919.
2. Earle, D. E. The classification and grading of cotton. U. S. D. A., Farmers' Bul. 591, 1914.
3. Earle, D. E., and Taylor, Fred. Classification of American Upland cotton. U. S. D. A., Farmers' Bul. 802, 1917.
4. Finch, Chester L. Standards for cotton classification in the United States and abroad. U. S. D. A., S. R. A., No. 92, 1925.
5. Miller, T. S. Cotton Trade Guide and Students' Manual. Austin, Texas, 1915.
6. Palmer, Arthur W. The commercial classification of American cotton. U. S. D. A., Dept. Cir. 278, 1924.
7. Regulations of the Secretary of Agriculture under the United States Cotton Standards Act. U. S. D. A., S. R. A., 95, 1925.

CHAPTER XVII

BREEDING OF COTTON

The improvement of cotton that has been brought about by the plant breeders during the last twenty-five years is truly marvelous. Because of their work, old varieties now produce a superior grade of fiber and are better adapted to the sections where they are grown. Besides, many new varieties have been given to the public, among which the varieties of Upland long staple and American-Egyptian are especially noteworthy.

The Results of Previous Breeding of Cotton. — Not so much breeding work has been done with cotton as has been done with some of the other major field crops. The breeding that has been done, either intentionally or non-intentionally performed, has brought about a marked change in the original characteristics of the plant. Cotton, a tropical, tree-like plant of perennial nature, has been converted into the temperate annual as we have it today. The selection of superior plants has resulted in the formation of varieties which vary widely as to their characteristics. In this way varieties have originated which far outyield the common cotton, and which have fully repaid the growers for the extra time, trouble, and expense put forth.

When Sea Island cotton was first introduced into this country, our seasons were too short for its successful production. But from this early cotton varieties have been bred which complete their growth in our growing period. Likewise, the length of the fiber as first introduced was only $1\frac{1}{2}$ inches, while today it is $2\frac{1}{2}$ inches.

The Work of the Plant Breeder. — Because of the nature of plant breeding, the farmer cannot afford to take the time and go to the expense of putting into practice all of the facts known concerning the improvement of cotton through breeding methods. There are many phases which had better be left to the plant breeder, who makes plant breeding his profession, and who devotes his entire time to that one subject. The farmer can receive the benefits of the plant breeder's work by purchasing his seed from him. It is true that the seed may cost him considerably more than ordinary seed, but he is usually fully repaid when harvesting time arrives. However, there are certain breeding practices, which will be discussed later, that the farmer can, and

often should, perform in order that his cotton may at least maintain its good qualities, even if no improvement is desired.

“Running Out” of Cotton. — The term “running out” is generally used by the farmer to designate the gradual decline of the acre yield of his cotton. His plants seem to decrease in size, vigor, and yielding power year by year. This condition of affairs actually takes place, and may be due to either one of two factors, or both. First, in a number of cases part of the decrease is due to the decline in the fertility of the soil; and, second, the condition may be brought about by the grower’s careless methods of securing seed for planting purposes. It is estimated that fully one-half of all the cotton seed planted in the United States is secured from cotton ginned at a public gin. This means that the farmer may or may not get the seed from his own seed cotton. The seed of good and bad types of cotton from all parts of the community may, and do, become mixed within the gin, and consequently produce a poor crop of cotton the following year. The seed roll of the ordinary gin contains 30 to 35 pounds of seed, and this seed is continually being replaced by other seed during the process of ginning.

All plants within a field may look alike to the unobserving, but every variety or type of cotton has within it poor, medium, and good plants, when we consider such characteristics as the percentage of lint, lint index, yield of lint, length of fiber, uniformity of fiber, strength of fiber, number of bolls, size of bolls, length of joints, or what not. As in the average community the poor plants outnumber by far the good ones, seed selected from any public gin bin must yield a general crop of poor cotton. Furthermore, seed secured from the public gin are often small, light, and immature, and even though they germinate, produce plants of low vitality. In pre-boll-weevil days the seed ginned from the first, fourth, or later pickings, did not yield the best seed for planting purposes. It is not a good practice, however, for a farmer to change seed every few years unless he can get good seed from some good breeder in his community. He should get good seed to start with, and then follow methods that will insure him each year enough good seed for the next year’s planting.

Selection of Seed. — Selecting the seed to be planted is a matter of great importance. It has been found through experience that seed selected from plants producing long lint will produce plants which in turn will produce long lint, and that many other characters are inherited in the same way. Just by looking at the seed very little can be told concerning, for instance, its yielding power, or its resistance to disease, although large heavy seed have been found to produce better plants and to give larger yields, as a rule, than small light seed of the same variety.

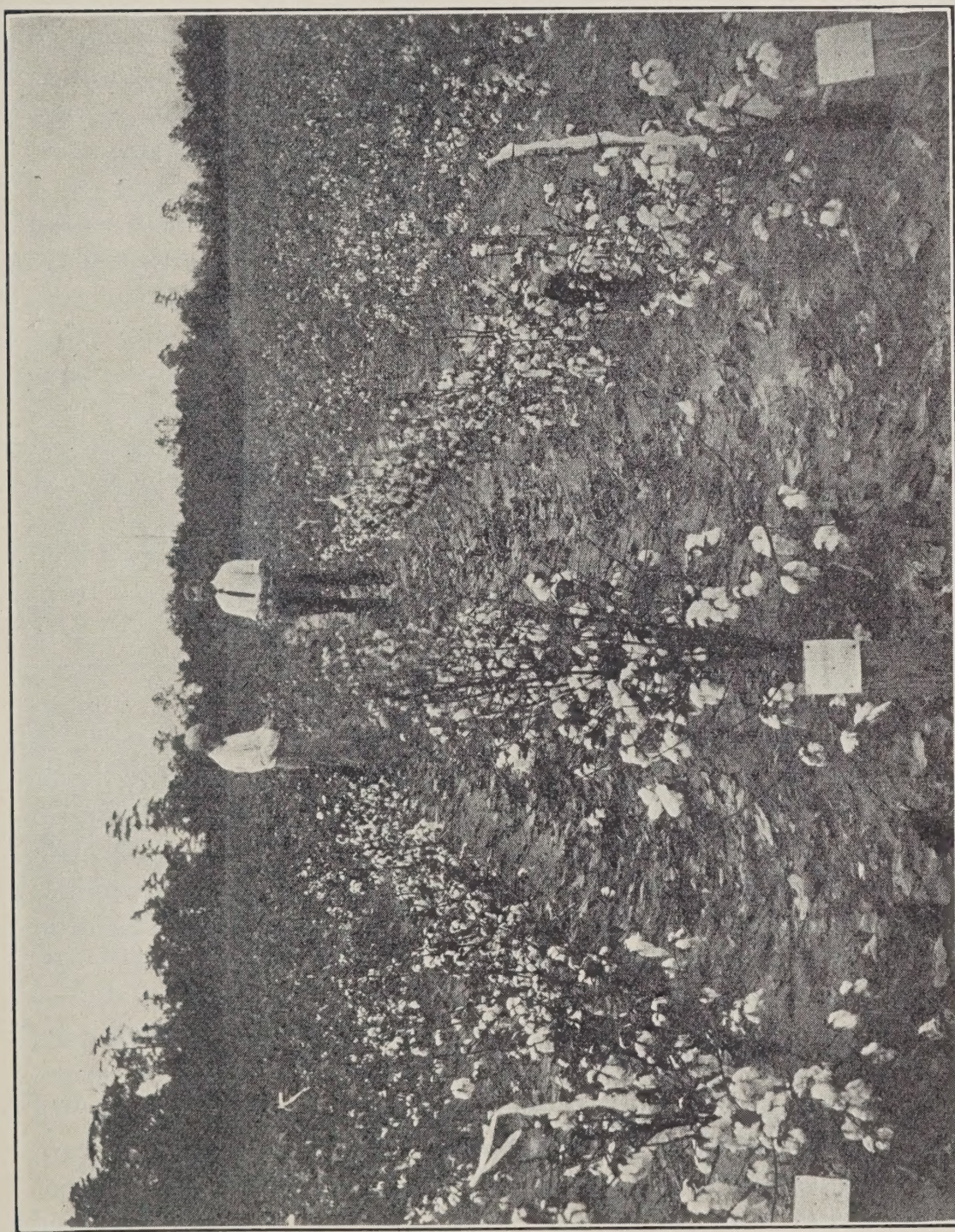


FIG. 84. — Plant-to-row test with Cleveland cotton. (Courtesy, Coker's Pedigreed Seed Company, Hartsville, S. C.)

Seed for planting must be selected from the growing plant if any uniformity at all is to be expected from the crop. When this method of selecting the seed is used, cotton may easily be improved or degraded according to the kind of breeding done. The principal objects usually sought through selection are: (1) increased productiveness, (2) increased size of boll, (3) improvement of the quality of lint, and (4) earliness.

Maintaining and Improving the Good Qualities of Cotton. — The improvement of plants by breeding is based on two processes: (1) selection, and (2) hybridization, or crossing.

Improvement of Cotton by Selection. — The improvement of cotton by selection is based upon its variability. This is the characteristic method of improving cotton, and may be practiced to some extent by the farmer. The cotton plant is one of the most variable field crops that we have. Outside influences, such as soil and climatic conditions, have a marked effect upon this variability. In order to secure the best plants the characteristics that are desired must be known and easily identified in the field. These characters may be: the quantity of seed cotton produced per acre; the lint index, which is the weight in grams of lint ginned per 100 seeds, and may vary from 4 to 8; the percentage of lint; the number of bolls; the size of bolls; earliness; storm-proof qualities; length of staple; disease resistance, etc.

Type of Plant Most Often Sought. — The type of plant most often sought is one of an early fruiting type of medium size, large and numerous bolls, high percentage of lint, high lint index, staple not less than $1\frac{1}{8}$ inches, plant not over 5 feet tall, vigorous, short-jointed, and hardy.

Characteristics of Early, Medium, Late, Rapid, and Productive Types. — As a general rule, early varieties have smaller bolls than late varieties, but not necessarily so. Medium-maturing varieties produce the largest yield of seed cotton, although the quantity of seed cotton produced is a very variable factor. The quantity of seed cotton produced varies more according to variety and environmental conditions than does the percentage of lint. The following types are recommended for early fruiting, late fruiting, rapid fruiting, and productiveness. For early fruiting: the first limbs must be low, not higher than the fifth joint above the seed-leaf joint. The vegetative limbs should be low, the first one should not be above the fifth joint, and they should not exceed four in number. For late fruiting: the fruiting branches should come out high on the main stem, and all the joints should be long. For rapid fruiting: the fruiting and vegetative limbs should grow in succession at each joint of the main stem and primary limbs, and should be continuous in growth and continuous in fruiting. In no case should the joints be over two to three inches long. For productiveness: the

plants should be large and have a good rate of growth. The bolls should be numerous and not less than one and one-half inches in diameter, well formed, and should open early and produce a high percentage of lint. The percentage of lint should not be less than $33\frac{1}{3}$ and the lint index not less than 7. Five-lock and four-lock bolls are preferred to those that have three locks.

Experiments conducted by the Bureau of Plant Industry in 1919 and 1920 showed the weight of seed cotton per boll to be 10 per cent and 7 per cent, respectively, greater in four-locked than in three-locked bolls. Henry Dunlavy, in 1921, examined 1185 five-lock bolls, and 725 four-lock bolls, and found that the five-lock bolls were 11.2 per cent heavier than the four-lock bolls.



FIG. 85. — Proper method of enclosing a cotton flower to prevent accidental cross-pollination. (Courtesy, U. S. Dept. of Agriculture.)

Characteristics of Storm-Resisting Types. — The degree of storm resistance of a plant depends upon: (1) the presence of large bracts; (2) burs that do not turn back; (3) drooping position of the boll; (4) sufficient space between the locks to make picking easy, but close enough together that the locks do not hang separately.

Characters Seldom Found Together. — It should be kept in mind that there are some characters which are not usually found together in the same plant. For example, large bolls and earliness; long fibers and high percentage of lint; largest yield and extreme earliness, unless

under boll-weevil conditions. Likewise, a high percentage of lint, 38 to 40 per cent, is seldom found with large seed.

Linkage of Characters. — Sometimes a character has linked up with it a number of other characters which may aid in magnifying it. For instance, high yield may be associated with low-fruited branches, large bolls, short period of setting of squares and boll development, disease resistance, high percentage of lint, etc. With the Sea Island cottons wide-opening bolls are usually correlated with short staple and large perfectly bare seed with low ginning rate.

Work for Some Definite End. — During the process of selecting, the grower should always have in mind a certain type toward which he should work. This type should be clearly defined, and not changed as often as the years roll by, if any progress is expected. If the grower is selecting for large bolls he should not change to selecting for a large number of bolls after two or three years of the former selecting. It is also a good policy to select for but one or a few characters at a time. It will be found that the desired goal will be reached more quickly if, for instance, large bolls are selected for, rather than large bolls, earliness, and a high percentage of lint all at once.

Making the Selections. — In some cases where the owner of the plantation does not live on the place, he may choose pickers that stay on the place from year to year to do the selecting. Of course, this is not as satisfactory as doing the selecting himself, but it is better than doing nothing. The process of selection is not costly nor difficult, as many farmers think, but is easily and quickly performed once the grower has had the patience to follow out each step carefully. The person engaged in the selecting soon learns to pick out the plants that are nearest the type desired. He should pass through the field, taking one row at a time, some time between the first and second, or second and third pickings, and mark the best appearing plants by attaching to some part of the plant, so it can be easily seen, a rag or tag. It is best that he select twice as many plants as he wishes to keep, and then go back through the field and carefully consider each plant as to the characteristics desired in the type bred for, and discard the poorest half of those first selected. No plant should be included that has marks of disease upon it, even though otherwise satisfactory. This susceptibility to disease may be inherited. The number of plants finally retained for breeding purposes should probably be between fifty and one hundred. When the time comes for the seed cotton to be picked for seed, a careful picker, preferably a day hand, should be sent through the field ahead of the other pickers to gather the cotton from the selected plants. The seed cotton from each plant should be numbered in some way. A good

plan is to number the bags consecutively as they are filled, giving the first bag number 1, and the second bag number 2, etc. The seed cotton from each bag should be carefully ginned, care being taken that the seed from one bag does not become mixed with seed from any other. A small ten-saw motor or hand power gin is absolutely necessary when large numbers of samples are to be ginned. After the seed cotton has been ginned the seed should be returned to the same bag which contained the seed cotton. At the time of ginning notes should be taken as to the percentage, the length, the uniformity of the lint, etc. Also it may be desirable to keep samples of both the lint and the seed for future reference.

Necessity of Testing Out the Selected Plants. — Although the grower may have his ideal of type clearly defined in his mind, and may have made his selections very carefully, he has by no means reached his goal

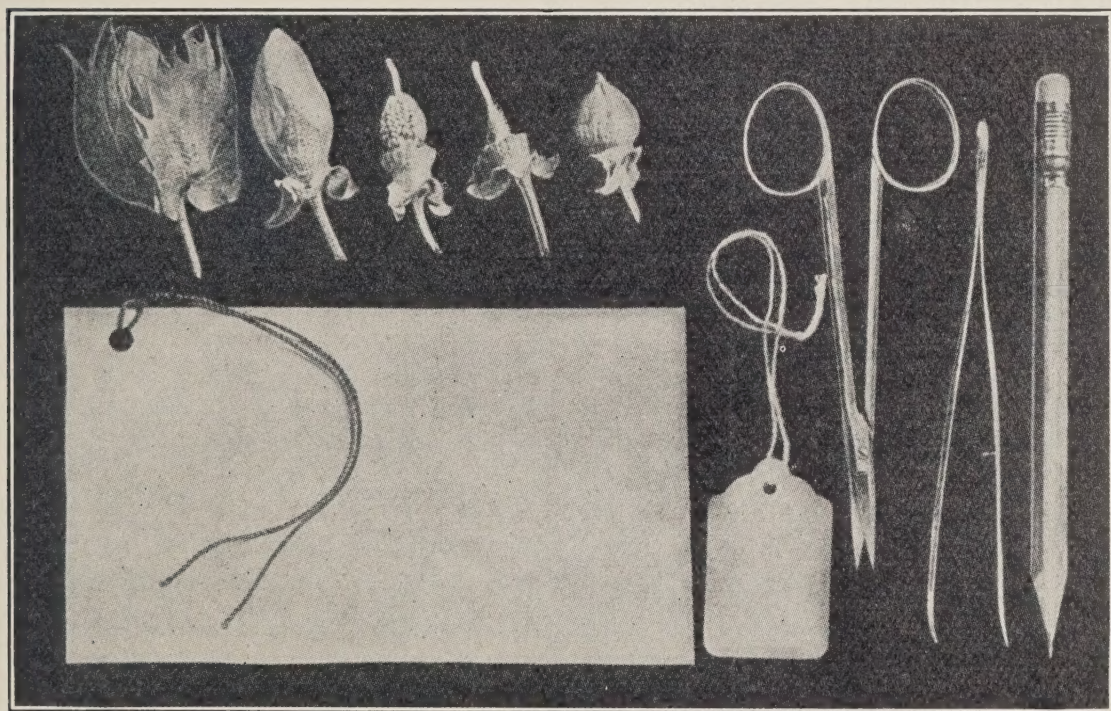


FIG. 86. — Crossing outfit. Showing the steps in emasculation, and boll three days after pollination. (Courtesy, Georgia Experiment Station.)

at this stage. The progeny of each plant must be tested out, weeded out, and the process of selection continued for five to eight years before his type can be considered as fixed. The grower has selected his plants so far as to their appearance in the field, but the appearance of the plant in the field is affected not only by internal hereditary characters but also by outside environmental forces. Thus, it will be the work of the grower to discard the progeny of the plants selected which appeared

to be good plants, because of some environmental conditions, and to preserve the progeny of those plants whose excellency was based upon their heredity.

Planting of the Seed. — In the following spring the seed should be planted upon uniform land, which has been well prepared. This plot, if possible, should be at least one-fourth of a mile from all other cotton, and if it is separated from other cotton by a strip of woods so much the better. This will eliminate the crossing which would naturally take place if the plot were situated near other cotton. While cotton may cross freely, the extent of crossing is only about five to ten per cent as great as that of corn. The extent of crossing will depend upon the climatic conditions, the kind and number of insects visiting the plants, the distance of the breeding plot from other cotton, and the vitality of different pollen. The seed from each plant selected should be planted in a separate row. This is called the plant-to-row method of breeding. The rows should all be of the same length, and the same quantity of seed should be planted to each row. A cotton plant produces from 500 to 1500 seeds, so that it is possible that at least 500 plants could be secured as a final stand in each row. The row planted from the seed of Bag No. 1 should be designated Row No. 1, from the seed of Bag No. 26, Row No. 26, etc. The rows should be far enough apart to give the plants plenty of room, so the distance between rows will depend upon the size to which the plant naturally develops. The seed should be planted rather thinly, or later thinned out, the distance to be left between the plants in the row likewise depending upon the natural habits of the plant. In some cases it may not be necessary to gin the seed cotton selections. In such cases a lock, or a lock and a half, should be planted to the hill, care being taken to pack the soil carefully around the seed in order that germination may not be delayed longer than necessary. The cultural operations should be of the best, and uniform for all the rows.

Harvesting the Plant-to-Row Selections. — When the harvesting period of the second year arrives, the grower should pass through the field and determine as nearly as possible from the outside appearance which rows contain the most plants nearest the type for which he is working. The rest of the rows should then be discarded, the cotton picked from these being mixed with the cotton from the regular crop. All rows that are not uniform should also be discarded, for the transmission powers of the selection must be good. He should then take the rows selected and pass carefully down each row, noting the characteristics of each plant. Plants in the row which most nearly approach his ideal should be marked and numbered. A good method of numbering

the plants is to give to the plants as they are selected consecutive numbers, as in the previous year. However, in order to know the relationship of their progeny in the future, the number of the row must also be recorded. This can be done by prefixing to the number of each plant the number of the row and a dash. If, for instance, five plants should be selected out of Row No. 26, their numbers would be 26-1 to 26-5 inclusive. Enough seed cotton from each selected plant should be picked to gin a sufficient quantity of seed to plant a row as long as the row in which it grew. The seed cotton from each row must now be harvested separately. However, the weight of the seed cotton from all the selected plants from each row should be totalled and added to the rest of the seed cotton secured from the row, in order that a fair comparison as to yield between the individual rows may be made. After the highest yielding rows are determined, enough of the selections within the highest yielding rows should be saved to plant the desired number of rows to be in the breeding plot of the next year. If there are any selections left over more than required, they may be mixed with the seed from the rows from which they were selected. The following spring the same method of planting the seed selected should be pursued as in the preceding year. The seed cotton from all the uniform rows may now be mixed and ginned at the same time, the seed being used to plant the next year's general crop, or the seed from only the highest yielding rows may be reserved to plant the following year a small patch of cotton which is sometimes called a multiplying plat, from which seed can be secured for the general crop of the second year.

Continuation of Selection. — These processes may be continued year after year. In this way the good qualities of the cotton should be maintained and such a thing as a "run-out" crop eliminated. The following diagram shows how, within three years, enough seed can be secured from one plant to plant the general crop of the fourth year.

<i>First Year</i>	<i>Second Year</i>	<i>Third Year</i>
1. (Plant selected)	500 plants	5 acres
	1. (Plant selected)	500 plants
		1. (Plant selected)
<i>Fourth Year</i>	<i>Fifth Year</i>	
general crop	general crop	
5 acres	5 acres	
500 plants	500 plants	
1. (Plant selected)	1. (Plant selected)	

The method described above is also used by breeders though they go into more detail in the selection of their plants and in the method of keeping of records.

The Improvement of Cotton by Hybridization. — The improvement of cotton by hybridization, or crossing, should be left entirely with the plant breeder. The object of hybridization is to secure a plant which will have the good qualities of the two plants crossed. Just as in the process of selection, the breeder must have some clear-cut type in mind.



FIG. 87. — Appearance of breeding plot a few days after flowers have been hand pollinated. (Courtesy, Georgia Experiment Station.)

Likewise, the plants that are to be worked with should be of pure varieties which most nearly approach the grower's ideal, and of selected plants within these varieties which seem to approach his ideal to the nearest degree.

Selfing. — In order to secure pure varieties or types upon which the work of hybridization can be performed, it is sometimes necessary to allow self-pollination to take place under close observation for a few generations previous to beginning the work of hybridization. This process is known as selfing. When only a few flowers are to be selfed, the squares may be covered with paper bags the day before they are to open, thus preventing contamination by foreign pollen, and forcing the flowers to fertilize themselves. The paper bags should be allowed to

remain until the bolls have set. Another good method, and one which has proved very satisfactory, is to coil a piece of copper wire around the unopened corolla the day before it is to open. In this way the corolla is prevented from opening, and the same thing is accomplished as when the flower has been covered with a bag. No extra labor is required to remove the wire, for as soon as the boll is set the corolla is cast from the plant, and the wire with it. When it is desirable to self the flowers of an entire plant, a covering of mosquito netting can be placed over the plant before the period of blooming commences. This method usually gives satisfactory results, but absolute purity cannot be assured.

Inheritance of Characters. — When plants which contain unlike characters are crossed, these characters may combine in the progeny in almost every conceivable way. The combinations found in the progeny of the first generation may or may not produce plants like themselves, or breed true. Therefore, plants which are selected from a first generation cross cannot be counted upon to reproduce the kind of plants that they appear to be.

When two plants are crossed whose characters are different, the character of one parent may appear in the offspring, while the corresponding character of the other parent is seemingly erased. For example, if a plant having red leaves is crossed on a plant having green leaves, all the progeny of the first generation will have red leaves. The character that shows itself in the first generation is known as the dominant character, and the character that does not show itself is spoken of as the recessive character. Two characters such as these are spoken of as an alleomorphic pair. Sometimes, however, the dominant character is not so pronounced and the recessive character not so much erased as in the above example. Characters which behave in this way are spoken of as incompletely dominant.

The Georgia Experiment Station has done considerable work on the study of the dominant and recessive characters of cotton. The following table, taken from Georgia Experiment Station Bulletin 99, sums up their work in a brief and concise way:

ALLEOMORPHIC PAIRS OF UNIT CHARACTERS WITH DOMINANT OR IN-COMpletely DOMINANT FIRST

Leaf

1. Light green dark green
2. Red green
3. Red spots no spots
4. Glabrous petiole hirsute petiole
5. Narrow segments wide segments
6. Large small

Flower

- 7. Red spot of petals no spot
- 8. Reddish petals white petals
- 9. Yellow petals white petals
- 10. Large petals small petals
- 11. Yellow anthers buff anthers
- 12. Long filaments short filaments
- 13. Long style short style
- 14. Long column short column
- 15. Red involueral bracts green involueral bracts
- 16. Large involueral bracts small involueral bracts
- 17. Early flowering late flowering

Boll

- 18. Reddish green
- 19. Few loculi many loculi
- 20. Long and narrow short and wide
- 21. Pitted surface smooth surface
- 22. Anthracnose susceptibility anthracnose resistance

Plant Body

- 23. Tall stem short stem
- 24. Basal branches no basal branches
- 25. Late maturity early maturity

Lint

- 26. Colored white
- 27. Even distribution uneven distribution
- 28. Regular length irregular length
- 29. Long short
- 30. Weak strong
- 31. Sea Island (or Egyptian) quality Upland quality
- 32. Good drag poor drag
- 33. Low per cent high per cent

Seed

- 34. Colored fuzz white fuzz
- 35. Fuzzy no fuzz
- 36. Little fuzz no fuzz
- 37. Heavy light

Breeding work in Egypt with Egyptian cotton has shown that the lint characters are inherited in a manner similar to that reported by the Georgia Station. It also showed that silky lint was dominant over harsh lint.

Where parent plants were selected for high and low oil content of seed, the Texas Station has been able to secure a maximum difference of

4.94 per cent between the high and low oil strains of the first generation progeny.

H. M. Leake and A. E. Parr have shown that with certain Indian cottons there are two color factors, red and yellow, that may combine to form flowers of three different colors. Where both factors are present in a plant, the flowers are a full red color; where red is present and yellow is absent, the flowers are pink; while if yellow is present and the red is absent, the flowers are yellow.

When old world types of cotton are hybridized, the hybrids show a tendency to produce plants with a more complicated arrangement of branches and leaves than the normal one-third spiral. On the other hand, with Upland hybrids the tendency is toward an arrangement simpler than normal. Mutative variations may agree in leaf arrangement with the parent stock or may show different arrangements.

Time of Crossing. — The best time to cross, or hybridize, cotton is about three to four hours after sunrise. At this time the stigma is receptive for the pollen, being covered with a sticky substance which exudes just before the receptive period. Also, about this time the anthers, or pollen sacks, begin to burst and the pollen grains are set free. Just before sundown of the day previous to the day the crossing is to be done, the breeder should select the plants that are to be crossed. Mead and Kearn have shown that hand-pollinated cotton set more squares, and produce more seed and more seed cotton than self-pollinated plants. As a result of their investigation they conclude that because bees are so efficient in cross-pollinating cotton, bee-keeping may be a profitable industry to combine with cotton growing.

Emasculating and Crossing. — Only those flower-buds that will open the next morning can be used in crossing. The flower-buds that are selected to act as the female member of the union must be emasculated. In order to do this it will be necessary that the greater portion of the corolla be cut away so that the stamens will be accessible. A pair of curved emasculating scissors, or a small knife, will serve this purpose. The anthers may be cut off with the same instruments, but care should be taken that the pistil be not injured in so doing. As soon as the flower-bud has been emasculated it should be enclosed in a paper sack of good quality, in order to prevent foreign pollen from getting to the pistil. The flower-buds which are selected to represent the male member of the union need only be covered with the paper bags so that the pollen may not become contaminated with foreign pollen. The crossing should be done between nine and ten o'clock in the morning. A good way of transferring the pollen from the male to the female flower is to cut off the male flower and carry it to the emasculated female flower.



FIG. 88. — A net used for selfing an entire plant. (Courtesy, Georgia Experiment Station.)

The bags should be removed from each of the flowers, and the pollen from the male flower shaken onto the pistil of the female flower. After this has been done the bag should be replaced on the female flower, and a tag attached showing the cross made. For instance, if Cook cotton is crossed on Cleveland, the tag should be marked Cook X Cleveland, and is read, "Cook on Cleveland." At the same time this record



FIG. 89. — Showing the use of the selfing wire. (Courtesy, U. S. Dept. of Agriculture.)

should be recorded in a notebook. Duplicate crossings should be made so that sufficient seed can be secured to produce at least 100 plants of the cross the following season. After the bolls have set, the bag may be removed, but the tag must still remain. Careful crossing during the early or middle part of the flowering season should yield good results, as 90 to 100 per cent of the crosses made should set bolls. The percentage of the bolls that will set will depend upon: (1) the period of flowering in which the cross was made, (2) climatic conditions at the time of pollination, (3) the care with which the bags were put on, (4) the length of time the bags were allowed to remain, and (5) the durability of the bags.

Harvesting and Selecting. — When harvesting time arrives a close watch must be maintained in order to secure the seed cotton from these crosses at the right stage. The seed cotton should be picked from each and kept in separate bags, ginned, and planted in plant-to-row tests in the same manner as previously described in the plant selection work. After the progeny of these crosses have been grown, a process of selection like that already described, but by far more complex, must begin. All kinds of combinations of the characters of the two plants crossed may take place, and since a plant of the desired type may appear only one time in a thousand, necessarily, it must be recognized when it does appear.

An example of what may be expected from crossing often appears in Sea Island cotton fields, where hybridization of the Sea Island and the American Upland cotton has taken place the previous year. This cotton is often referred to as "male stalks" or "bull cotton." They are easily distinguished by their large size and vigor. They yield very little lint, and then usually of an inferior quality. These are usually rogued out in order to allow development of surrounding plants.

Even if the plant desired has been secured, because it is a cross or a hybrid, it will not breed 100 per cent true, and a great amount of further selection and roguing out of unfit plants must be made in order to separate out a type that will breed even fairly true to form.

REFERENCES

1. Balls, L. Some cytological aspects of cotton breeding. A. B. A., Vol. 5, 1909.
2. Bennett, R. L. A method of breeding early cotton to escape boll-weevil damage. U. S. D. A., Farmers' Bul. 314, 1907.
3. Coker, David R. The field for economic plant breeding in the cotton belt. A. B. A., Vol. 4, 1907.
4. Cook, O. F. Cotton improvement on a community basis. U. S. D. A., Agr. Yearbook, pp. 397-410, 1911.
5. Cook, O. F. Dimorphic branches in tropical crop plants; cotton, coffee, cocoa, the Central American rubber plant, and the banana. U. S. D. A., Bur. of Plant Industry, Bul. 198, 1911.
6. Cook, O. F. Dimorphic leaves of cotton and allied plants in relation to heredity. U. S. D. A., Bur. of Plant Industry, Bul. 221, 1911.
7. Cook, O. F. Mutative reversion of cotton. U. S. D. A., Bur. of Plant Industry, Cir. 53, 1910.
8. Cook, O. F. Hindi cotton in Egypt. U. S. D. A., Bur. of Plant Industry, Bul. 210, 1911.
9. Cook, O. F. Origin of Hindi cotton. U. S. D. A., Bur. of Plant Industry, Cir. 42, 1909.
10. Cook, O. F. Suppressed and intensified characters in cotton hybrids. U. S. D. A., Bur. of Plant Industry, Bul. 147, 1909.

11. Dunlavy, Henry. Frequency and importance of five-lock bolls in cotton. Jour. Am. Soc. Agron., Vol. 13, No. 8, 1921.
12. Hodson, Edgar A. Correlation of certain characters in cotton. Arkansas Exp. Sta., Bul. 169, 1920.
13. Hodson, Edgar A. Lint frequency in cotton, with a method for determination. Arkansas Exp. Sta., Bul. 168, 1920.
14. Kearney, T. H. A plant industry based upon mutation. Jour. Heredity, Vol. 9, pp. 51-61, 1918.
15. Kearney, T. H., and Wells, W. G. A study of hybrids in Egyptian cotton. Am. Nat. 52, 1908.
16. Kearney, T. H. Pollination of Pima cotton. Jour. of Heredity, Vol. XII, No. 3, 1921.
17. Mell, P. H. Hybrids from American and foreign cottons. Alabama Exp. Sta., Bul. 93, 1897.
18. Meade, Rowland M. Bee keeping may increase the cotton crop. Jour. of Heredity, Vol. IX, No. 6, 1918.
19. McLendon, C. A. Mendelian inheritance in cotton hybrids. Georgia Exp. Sta., Bul. 99, 1912.
20. Webber, H. J. Improvement of cotton by selection. U. S. D. A., Agr. Yearbook, p. 381, 1902.
21. Webber, H. J. Method of pedigree breeding recommended for improving cotton. A. B. A., Vol. 3, 1907.

CHAPTER XVIII

BY-PRODUCTS OF THE COTTON PLANT

The production of the cotton plant is primarily for the lint, or fiber, that it produces. Next to the fiber, the seed is the most important consideration. From the stalks a good grade of paper can be made and a coarse fiber may be secured from the vascular system.

Recent Development of the Cottonseed By-product Industry. — It was not until the latter part of the nineteenth century that a commercial use was made of the cotton seed. Up to that time the seed was either used as a fertilizer, the value of which was not considered to be of any great importance, or it was dumped in huge piles somewhere near the ginneries. Because of the necessity of handling the cotton seed, and of disposing of them with as little expense as possible, the gins were often built over running streams, so that as the cotton was ginned the seed could be run out through a chute into the stream, thus eliminating the cost of handling them a second time. However, in some cases the seed so disposed of collected on the banks of the stream below the gin in such quantities that there arose, through the decay of the seed, conditions which in some cases required the interference of the health boards. In disposing of the seed in this way hundreds of thousands of dollars' worth of fertilizer ingredients, to say nothing of the value of the oil contained therein, was lost annually throughout the South.

To England goes the credit of having first started the cottonseed by-product industry, and it was not until the industry had made considerable headway in that country that the American financiers inaugurated the industry in the South. The cost of the manufacture of the by-products was considerably greater in England, because of the fact that the cotton seed had to be transported long distances to the plants. These transportation charges being saved in the South, the by-products were put out at considerably less expense.

Prejudices Against Cottonseed Oil Products. — For a long time there was a considerable prejudice against the use of any of the manufactured products secured from cottonseed oil. For this reason a good many of the products manufactured from the oil were put out under trade names which would make the public believe that the product had been secured from some other source, or at least cover up the real source of the material. Hence, a large quantity of the so-called

vegetable oil which we have on the market today is no more than a preparation made from cottonseed oil. Also, a good many of the substitutes for lard are by-products of cottonseed oil.

By-products of the Cottonseed Oil Mills. — The by-products of the cottonseed oil mills are many and varied. All by-products can be classified into four great groups: the linters, the hulls, the cake, and the oil.

Most of the cotton seed produced in the South is covered with numerous short fibers, or fuzz. When the cotton seed arrive at the oil mills they are run through a special gin which removes this fuzz from the seed. This fuzz is then spoken of as linters, and is used in the manufacture of low grade ropes, twines, and wrappings and paddings, and also as a cellulose product from which gun powder and the various celluloid compounds may be made. After having been bleached and medicated they are also found on the market as absorbent cotton. All cotton seed does not contain this fuzz. As has been mentioned in other chapters, the Sea Island cotton seed are naked, so that linters cannot be considered as a by-product of these seed. The absence of this fuzz on Sea Island cotton seed explains to some extent why Sea Island cotton seed should weigh more per bushel than Upland cotton seed. The average weight of Upland cotton seed per bushel is thirty-three pounds, while that of Sea Island is forty-four pounds.

The hull, or testa, consists of the outer coat of the seed. This is removed from the meat, or that portion found within the hulls, by special machinery, and is used as a poor grade of stock feed, as a fertilizer, as packing, and as a basic material from which various kinds of paper are manufactured.

The "meat" is next heated and then run through an hydraulic press, which presses out the oil. After the oil has been separated, what remains is pressed into cakes, or ground into meal, and used as a stock feed and as a fertilizer. The average composition of cottonseed meal, according to 400 analyses made by the Texas Agricultural Experiment Station, and given in Bulletin No. 70, is as follows:

	Per Cent
Water.....	8.52
Ash.....	7.02
Protein.....	43.26
Crude fiber.....	5.44
Nitrogen-free extract.....	22.31
Fat.....	13.45

A rough estimate of the average proportion of linters, hulls, meat, oil, and water in a ton of cotton seed is about 150 pounds of linters, 450

pounds of hulls, 950 pounds of meat, 315 pounds of oil, and 135 pounds of water. This proportion will vary with the variety. It is thought by many that the basis upon which cotton seed will be sold in the future will be its oil content, just as milk is sold today upon the basis of its butterfat content.

Cottonseed Meal and Soil Fertility. — Nearly all of the seed now produced on Southern farms is sold, and cottonseed meal is bought in return by the farmer and used on the farm, both as a feed and as a fertilizer.

In this way the plant food elements that were removed in the seed may again reach the soil. It must be remembered that by far the greatest quantity of plant food elements is taken out of the soil by the cotton seed, the lint being made up almost entirely of pure cellulose, which contains elements derived entirely from the air and water. On the other hand, the cotton seed is rich in nitrogen, phosphorus, and potassium, as well as in fat. The fat is of no value as a fertilizer, so that the cotton seed produced on the farm should be sold, but sufficient quantities of cottonseed meal, or its equivalent, should be bought, fed, and returned to the land as manure, if a balanced fertility of the soil is to be maintained. A little less than two pounds of seed are produced on an average to one pound of lint, which means that there are about 1000 pounds of cotton seed for every 500-pound bale of cotton lint.

Oil Mills. — The cotton seed may be sold either directly to the oil mills or to the ginner. The ginner in turn sell to the oil mills. These oil mills are scattered throughout the Cotton Belt, and are not centralized to any great extent. This may be due to the fact that cotton seed are bulky, and long distance shipping freight rates prohibit centralization. According to the United States Department of Agriculture, there were, in 1923, 532 seed crushing oil mills within the Cotton Belt.

CHAPTER XIX

FEEDING VALUE OF COTTON

Although the cotton seed is the only portion of the plant that is usually considered as a source of feed for livestock, yet the plant itself does have a feeding value and is relished by farm animals. It has long been the custom in some sections to turn livestock into the cotton fields after the seed cotton has been picked, although the amount of roughage secured at this late date from the cotton is not very large. Since the entrance of the boll weevil into the Cotton Belt some farmers have pursued the practice of turning the stock into the fields after the seed cotton has been picked, but before frost, rather than following the superior practice in weevil control of turning the plants under.

Feeding Value of Cotton Plants. — The feeding value of the leaves, bolls, burs, and stalks is indicated in the following table as determined by the Texas Station in 1919:

PERCENTAGE COMPOSITION OF LEAVES, BOLLS, BURS, AND STALK

Composition	Leaves	Bolls	Burs	Stalk
Protein.....	15.58	11.11	6.35	6.69
Ether extract.....	7.44	3.30	1.59	.73
Crude fiber.....	9.93	31.14	34.15	41.22
Nitrogen-free extract.....	42.78	41.41	42.15	39.70
Water.....	6.78	7.73	8.82	7.36
Ash.....	17.49	5.31	7.24	4.30

It will be noted that the leaves furnish a higher percentage of protein, ether extract, nitrogen-free extract, and ash than the bolls, burs, or stalk. The stalk contains a higher percentage of crude fiber and a smaller percentage of nutrients than the bolls or burs.

According to Duggar, where the yield of cotton lint is about 300 pounds per acre, the seed cotton will make up about 33 per cent of the dry matter produced, the burs 15 per cent, the leaves 22 per cent, the stems 23 per cent, and the roots 7 per cent.

Feeding Value of Cotton Seed. — As has been pointed out in another chapter, cotton seed may vary widely as to composition. On the average it carries about 16 per cent fat or oil, and 20 per cent protein. The seed was formerly fed to a greater extent than it is at the present time. The high oil content gives to the feed a laxative effect that is often undesirable. The seed should not be fed if it has been allowed to deteriorate by heating.

Feeding Value of Cottonseed Hulls. — Besides the ordinary cottonseed hulls which may be bought on the market, another allied by-product known as cottonseed hull bran may be secured. Cottonseed hull bran differs from ordinary hulls in that a greater percentage of the linters has been removed from the seed from which the hulls were made than is usually the custom. The feeding value of the product is very little above that of ordinary hulls.

Cottonseed hulls are extensively used, especially in the South, for roughage for cattle, although because of their low palatability and digestibility they are not well suited for dairy cows. The percentage of crude protein in cottonseed hulls is very low, but a small part is digestible. Every hundred pounds of hulls contains about one-third of a pound of digestible crude protein. Cottonseed hulls should be fed with feeds rich in protein.

Feeding Value of Cottonseed Meal. — After the meats of the cotton seed have been subjected to considerable pressure in the hydraulic oil presses and the oil has been removed, the residue is taken from the press as a hard, yellowish, board-like cake. This cake may be ground to a fine meal, which the trade in the Eastern and Central states demands, or it may be broken into pea or nut size which is demanded by the trade in the Western states. If the material is intended for export it is often shipped as cake. Occasionally cottonseed meal which contains a high percentage of hulls is put on the market as cottonseed feed.

The feeding value of fresh and wholesome cottonseed meal depends upon the percentage of protein it contains. The percentage of protein varies widely, depending upon the amount of hulls the meal contains. Choice cottonseed meal, which is the best grade sold on the market, must contain at least 41 per cent of crude protein. An average composition of 400 samples is given in Chapter XVIII. The oil content of cottonseed meal usually runs over 8 per cent. Because of the great variation in composition, cottonseed meal should be purchased on guarantee. Cottonseed meal when rationally fed is considered one of the most valuable feeds and one of the cheapest available sources of protein.

Toxic Properties of Cotton Seed and Cottonseed Meal. — Although cottonseed meal ranks high as a feed from a chemical standpoint, it

cannot be used indiscriminately as a feed. As has been shown by Withers and Carruth, of the North Carolina Station, cottonseed meal contains a toxic ingredient called gossypol which has more or less of a poisonous influence on all farm animals. This substance is a yellow compound and can be extracted from the cotton seed with ether. Because it is destroyed to some extent by heating, cottonseed meal is less poisonous to livestock than cotton seed.

Swine are more susceptible to the toxic influence of cottonseed meal than is any other class of livestock. No successful method of feeding cottonseed meal or cotton seed in large quantities to swine has as yet been worked out. Such practices as supplying succulent feeds, keeping the animals on pasture, or souring the feed have been found to help. Henry and Morrison state that when as much as one-third of the concentrates fed pigs is cottonseed meal the pigs thrive at first but later may become sick and die.

Steers when closely confined and fed heavily on cottonseed meal often become blind, and frequently die. Nevertheless, large numbers of steers are fattened at oil mills. The ration commonly given is 6 to 8 pounds of cottonseed meal with cottonseed hulls or corn silage as roughage. Young calves are especially susceptible to the toxic influence when given as much as one-fourth to one-half pound of cottonseed meal per head per day. Milk cows can take rather a heavy allowance without harm.

Sheep should not be fed more than one-fourth to one-third of a pound of cottonseed meal per head per day.

Horses and mules can be fed restricted amounts, especially when fed with bulky feeds. It is not usually relished alone. Generally speaking, not over one pound should be fed daily per 1000 pounds of live weight.

Cottonseed meal has a tendency to harden the fat of all animals to which it is fed, and in the case of dairy cattle it produces a hard, tallowy butter, light in color, and poor in flavor.

REFERENCES

1. Henry, W. A., and Morrison, F. B. Feeds and Feeding. Madison, Wis., 1921.
2. Withers, W. A., and Carruth, F. E. Gossypol, the toxic substance in cottonseed meal. Jour. Agr. Research 5, pp. 261-88, 1915.

CHAPTER XX

COTTON REGIONS OF THE WORLD

By far the greatest portion of the world's cotton crop is produced in the southern part of the North Temperate Zone. The United States alone produces more than one-half of the crop. India, China, Egypt, Brazil, and Russia follow the United States in production in the order named.

Practically all of the world's crop is produced south of the thirty-seventh parallel of north latitude. In Russia, however, the cotton growing area extends as far north as the forty-second parallel, which is about the same latitude as Boston and Chicago.

Cotton Production in the United States. — Cotton production in the United States is confined to the southern half of the country. The American Upland is found growing in Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Missouri, Arkansas, Alabama, Mississippi, Louisiana, Oklahoma, Texas, New Mexico, Arizona, and California. The Sea Island is produced principally in South Carolina, Georgia, and Florida; although at the present time it appears that the industry is completely destroyed by the boll weevil. The American-Egyptian is produced in New Mexico, Arizona, and California, and entirely by the use of irrigation.

India. — India has an area devoted to cotton of about two-thirds that of the United States, and an area suited to cotton production twice that of the United States. Nevertheless, the average acre yield is so low that the total production is only about one-third as great. The fiber produced is similar to that grown in China. About one-half of the total production is exported to Japan.

Although cotton has been grown in India for 4000 years, it was not until the cotton famine of 1860 to 1865 that a marked increase in the production occurred.

While some cotton may be found growing in nearly all parts of India, the largest amount of production is found in the Presidencies of Hyderabad, Berar, Bombay, and Madras. Most of the cotton produced in Sind and Punjab is grown under irrigation.

China and Chosen. — The cotton that is grown in these countries is coarse, poor in quality, and averages only about $\frac{5}{8}$ of an inch in length. The production of cotton in recent years has increased remarkably, but

it has not reached such a point that the local demands can be satisfied. For this reason very little of the crop is exported. China's cotton crop is estimated at over 1,500,000 bales. The native cottons of Manchuria and Chosen are hardier than the American Upland varieties. They only require a mean summer temperature of 72 degrees, which is 2 to 5 degrees less than that required by some of the American varieties.

Egypt. — Cotton production in Egypt is limited principally to the delta of the Nile, and to a narrow strip on the western side of the river which extends up the Nile for at least 200 miles above the delta. The growing of cotton on a commercial scale was begun in 1820 when Brazilian, Sea Island, and other varieties were introduced. The present Egyptian cotton is said to be a mixture of these with the native tree cotton of the country. The production is accomplished altogether through irrigation.

The most striking characteristic of Egyptian fiber is its length of staple, combined with great strength and fineness.

The principal varieties grown in Egypt are the Ashmuni, Mit Afifi, Bamia, Gallini, Yanovitch, Abassi, Nubarre, Sakellaridis, and Assili. The Ashmuni variety formed the bulk of the Egyptian crop for many years, but it is now entirely superseded by the Mit Afifi.

Mit Afifi was discovered by a Greek merchant in the village of Mit Afifi. A bluish-green tuft at the end of a seed attracted his attention and upon planting it he secured a plant producing a fiber superior to the Ashmuni.

The Bamia was discovered in 1873. The plant is large and coarse, and less hardy than the Mit Afifi.

Like older varieties, Ashmuni and Mit Afifi are characterized by a brown, or more properly pinkish-buff, color of the fiber, but the Sakellaridis variety, which is now highest in favor among spinners, is nearly white, or almost as light in color as Sea Island cotton.

The average yield per acre is about 450 pounds. Although the acreage is only one-twentieth of that of the United States, the total value of the crop is about one-fifth of that of the United States.

Brazil. — The average annual production in Brazil for the years 1919-23 was 532,000 bales. Most of the crop is used by local mills. It has been estimated that Brazil has a possible cotton acreage of 30,000,000 acres, but because of the lack of capital, and the profitability of other crops, a very slow development is anticipated.

Russia. — The production of cotton in Russia is confined principally to Turkestan and Transcaucasia. The annual production for the years 1910-14 was about 1,000,000 bales. The average yield per acre for the same period ranged from 250 to 450 pounds. Most of the crop is con-

sumed in European Russia. Because of the economic conditions which have existed in the country during the last few years the production of cotton has been very low. For the five years, 1919-1923, the average production was only 176,000 bales.

Minor Cotton Regions of the World. — Among other sections of the world which produce small amounts of cotton may be mentioned Brazil, Peru, Mexico, West Indies, Australia, East Indies, Philippine Islands, Siam, Japan, Persia, Turkey, Greece, and a number of the African colonies.

REFERENCES

1. Cotton production and distribution. Bureau of Census Annual Bulletins.
2. Todd, John A. The World's Cotton Crop. A. and C. Black, London, 1923.

CHAPTER XXI

HISTORY OF COTTON PRODUCTION IN THE UNITED STATES

As has already been said, for some unknown reason cotton had not been introduced, or at least was not grown, in the present "Cotton Belt" of the United States when America was discovered.

Introduction of Cotton into the United States. — The early colonists either brought the seed of cotton with them, or imported it soon after their arrival. However, many theories are prevalent among farmers as to the origin of cotton in the United States. One of these theories, as given in Bulletin No. 8, of the Weather Bureau, is as follows:

"It is said by those who claim that the original plants came from Mexico, that in the early part of the present century (19th) the United States Minister then at the court of Mexico noticed this species of cotton growing in a comparatively wild state in that country, and whenever it was subjected to cultivation the resulting fiber was long, white, and beautiful. He requested permission of the Mexican Government to transport some of the seeds to his country for the purpose of experimenting with it to determine if it could be successfully grown in the United States. This request was refused. At a state dinner subsequently, however, the subject of cotton and its cultivation was introduced, and in the progress of the conversation the minister was informed that no objection would be raised to his exporting as many dolls to his country as he might desire. He immediately took the hint, and had a large number of dolls stuffed with the cotton seed and lint that he succeeded in securing from the most healthy and vigorous plants. These dolls were sent to Washington and the cotton seeds were distributed over the Southern states, and in years after became the cotton plant of the South. The accuracy of this incident is not vouched for, but it has received considerable credence in the southwestern portion of the Cotton Belt, and it is simply given as a matter of interest in this connection."

The first cotton planted by the settlers was in 1607 at Jamestown, Virginia. Thus, the State of Virginia became the first seat of the cotton industry in America. In 1664 colonists arriving from the Barbadoes at Cape Fear, North Carolina, brought with them cotton seed and later planted it for home use. Cotton was first planted in South Carolina in 1733, and in Georgia in 1734 or 1735. In 1758 a type of cotton known as White Siam is said to have been introduced into Louisiana. At this

time Louisiana belonged to the French, and it is thought that the French must have also introduced cotton into Louisiana from the West Indies, Cypress, and Turkey. In 1786, just ten years after the signing of the Declaration of Independence, a black-seeded cotton, which is supposed to have been Sea Island, was introduced into Georgia from the Bahamas. During this period a large number of importations of cotton must have been made from all parts of the world of which we have no record.

Importance of Cotton Before the Revolutionary War. — Cotton was found to be adapted to the soil and climatic conditions of the states south of Pennsylvania, but more particularly to those states south of Virginia. Nevertheless, the acreage planted to this crop at this early period, as compared with the acreage in other crops, was small. This was due to the fact that there was practically no demand for the fiber until after the Revolutionary War. Cotton was planted in amounts just sufficient to supply the needs of the colonists. The textile industry of England at this time was in its infancy, so that there was practically no outside demand. Furthermore, England was doing everything she could to discourage the manufacture of clothing by the colonists.

Creation of a Demand for Cotton. — With the beginning of the Revolutionary War, and the consequent cessation of the English trade, a greater demand for raw cotton in this country was created. This demand was augmented after the War by improvements and inventions which were taking place within the textile industry all over Europe.

Satisfying the Demand. — In order to satisfy this ever-increasing demand the European nations, and England in particular, began the importation of cotton from Turkey, Smyrna, the East Indies, West Indies, and Brazil, as well as America. At first only small shipments of cotton were sent from the United States. It was not until 1784 that a regular commerce in cotton was begun. During that year eight bags were received in England from the United States. The first regular exportation of cotton from Charleston was made in 1785 when one bag was consigned to Messrs. John and Isaac Teasdale and Company, Liverpool. In 1791, 277 bales (equivalent) were exported.

Cotton Mills in the United States. — Although an equivalent of 277 bales was exported from the United States in 1791, more cotton was imported that year than exported. Just at this time the cotton mills were being started in this country. There was one built at Beverly, Massachusetts, in 1788, and one was put in operation at Providence, Rhode Island, in the same year. Other mills were soon built. All the carding and spinning was done by power machinery, but the weaving

was done by hand looms until 1815, when the first power loom was built in Massachusetts.

Invention of the Cotton Gin. — The invention of the cotton gin in 1793 by Eli Whitney was the greatest boost to the production of cotton the industry ever received. The first gin was put in operation in Georgia in 1794. In 1795 one was put up in Mississippi, and one in South Carolina. By the end of 1796 there were thirty gins in operation in Georgia. About 487,000 pounds of cotton were produced in 1793, and by 1796 the production had increased to 10,000,000 pounds. By 1890, just one hundred years later, the production ranged between 5,000,000 and 10,000,000 bales.

Slavery. — The history of cotton in the United States cannot be discussed without saying just a word about slavery. As the demand for cotton became greater and greater, the institution of slavery became more firmly established in the Southern states. The slaves were needed in the production of cotton, and the production of large quantities of cheap cotton depended upon them. This institution grew alongside the westward expansion of the cotton-growing area until the War between the States in 1861–65.

The Cotton Famine. — Before the War between the States most of the cotton mills were in the New England States. When war was declared, these mills were cut off from their source of raw material. As a result the mills were forced to shut down, and no cotton goods were made except from a little imported cotton. This period of non-production is spoken of as the cotton famine.

History of Cotton Manufacture since 1865. — As soon as the war was over, the mills were reopened, so that by 1868 the quantity of manufactured products turned out by the mills was the same as in 1860. Since that time the manufacturing phase of the industry has grown by leaps and bounds.

History of Cotton Production from 1865 to 1914. — For some years after the surrender of Lee at Appomatox the production of cotton went through a critical stage. Before the war, cotton production depended largely upon slave labor. When the planters returned to their plantations they returned in most cases penniless and to ruined farms. No longer had they the capital with which to finance their production enterprises, and even if they had, the question of labor seemed to offer an almost insurmountable barrier. The freed slaves could no longer be organized and directed as before.

Nevertheless, the production of cotton was undertaken again, for cotton had always been the cash crop for these people, and more was known universally about the growing of this crop than about any other.

At first the wage system was inaugurated in the employment of the ex-slaves, but this soon proved to be somewhat unsatisfactory, for the ex-slaves were prone to migrate from section to section according to the prices offered in the different regions for labor. Following this system, a system was inaugurated of renting to the ex-slaves either for a definite amount of cotton, or for a certain percentage of the crop produced, a section of land as large as he and his family could cultivate. This system proved to be better adapted to the labor situation and has been followed to a greater or less extent up to the present time.

There was very little increase in the production of cotton for the first five years after the Civil War. From 1870 to 1879 the increase was gradual, but nothing to speak of. Between 1879 and 1898 production doubled, although the price of lint fell practically fifty per cent. The increased production was due largely to new areas being opened up to cotton production in Texas, Oklahoma, and Arkansas, and to the use of commercial fertilizers in the eastern states of the Cotton Belt. From 1899 to 1914 production continued to increase. As much as thirty-two per cent increase in production was made in the ten years following the Spanish War. Much new territory was again added to the cotton growing area in the first part of this period, and in a number of states the average acre yield was increased. Prices were fair up to 1914, when 16,000,000 bales were produced, which, together with the disturbance of the markets produced by the World War, caused a big drop in the market. It was during this period that cotton was introduced into the irrigated regions of California, New Mexico, and Arizona. The development of cotton manufacturing in the Southern states during this period was very marked, so much so that the South now bids fair to become the greatest cotton manufacturing center in the world.

History of Cotton Production During and Immediately After the World War. — The production of cotton never became so large during the World War, or after, as it was in 1914. As the war continued, the demand for cotton became greater and greater, and the average price for cotton ran from 11.2 cents in 1915, to 35.4 cents in 1919. At this point the bottom dropped out of the market and the average price declined to about 15.8 cents in 1920. This slump continued for about two years, although some improvement was gradually made in the market conditions. By 1923 the average price of cotton had advanced to 28.7 cents. This depression caused the migration of large numbers of negroes to the North and the abandonment of large areas of land, by both white and negro growers. During this period the Cotton Belt became practically entirely infested with the cotton boll weevil. It was also during this period that a national coöperative organization of

the cotton growers was founded. Such momentous factors as these cannot but help to bring about radical changes in the production of cotton during the next decade.

REFERENCE

1. Cotton crop of the United States, 1790-1911. U. S. D. A., Bur. of Statistics, Cir. 32, 1912.

CHAPTER XXII

PRODUCTION OF AMERICAN-EGYPTIAN COTTON

The term American-Egyptian is applied to a long staple cotton which is grown in the southwestern part of the United States. The term Arizona-Egyptian is often seen in literature and refers to the same cotton.

Origin of American-Egyptian Cotton. — American-Egyptian cotton was derived from, and selected out of, Egyptian cotton, the seed of which was imported into this country and planted at Yuma, Arizona, in 1901. The breeding work was done by the United States Department of Agriculture.

Localities of the United States Adapted to the Production of American-Egyptian Cotton. — Mainly because of the long growing period required by American-Egyptian cotton, there are only a few localities within the United States in which the successful production of this cotton can be carried on, other things being equal. These localities include the Colorado River region and the Salt, Gila, and Imperial Valleys. The lower part of the Rio Grande Valley has a long enough growing period, but the production of American-Egyptian cotton would likely prove unsuccessful because of the presence of the boll weevil.

Early Breeding Work with American-Egyptian Cotton. — Because of the similarity between the irrigated sections of our Southwest and the irrigated cotton-producing sections of Egypt, it has long been the opinion of men familiar with the various cotton-growing regions of the world that Egyptian cotton could be produced successfully in the United States. However, it was not until 1901 that experimental work with this object in view was attempted. That year the United States Department of Agriculture imported some Egyptian cotton seed and planted them at Yuma, Arizona. The crop produced from these seed was very unsatisfactory. Lack of uniformity was noticeable throughout the crop. Most of the plants had a tendency to "go to weed," were late in maturing, and were poor yielders. Breeding work was inaugurated in an attempt to select out of this heterogeneous mixture a strain of cotton that would be adapted to the Southwest, breed true, and produce a good yield. It was not until 1912, however, that a pure strain of a good-yielding cotton was secured and gave promise of the successful production of Egyptian cotton on a commercial scale. This

strain of cotton was called Yuma. Yuma cotton produces a pale, dull-pink colored lint averaging $1\frac{1}{2}$ inches in length, and a percentage of lint averaging 28. From a single plant, found growing in a field of Yuma cotton in 1910 at Sacaton, Arizona, another variety of cotton called Pima has been developed that produces larger bolls and is earlier than the Yuma. The lint is whiter in color, and ranges from $1\frac{5}{8}$ to $1\frac{3}{4}$ inches in length. The seed of the Yuma cotton was distributed to farmers in 1912, and that of the Pima in 1916.



FIG. 90. — Normally developed Pima plants at the mid season stage. Note the medium size of leaves and open foliage, the branches all of the fruiting type with numerous squares and young bolls. (Courtesy, U. S. Dept. of Agriculture.)

Maintaining a Supply of Pure Seed. — It was early recognized that if the varieties were to be maintained and their good qualities kept up to standard, some action would have to be taken either by the farmers themselves or by the United States Department of Agriculture in establishing a source of supply of pure seed. The matter was taken up by the growers' community associations working in connection with the United States Department of Agriculture. As a result a source has been established, and the growers are now able to obtain pure seed at prices little above the current oil mill prices.

Preparation of the Soil for American-Egyptian Cotton. — The field selected for cotton should be uniform in fertility, having a slight grade and preferably should have been in alfalfa for at least three years before

being planted to cotton. Since American-Egyptian cotton is grown under irrigation, the field must be leveled so that it can be irrigated uniformly. Unless the field is graded properly, some parts of the field will receive too little water and some others too much. The dry spots will necessitate extra irrigation, particularly during August and September. The heavier types of soil produce the largest yields. Any soil that will grow good alfalfa should grow good cotton.

Early and thorough preparation of the soil is emphasized. Where land is to be put in cotton for the first time, plowing, discing, and harrowing may be done in August and then again in November or December. If the cotton follows cotton, a stalk cutter should first be run over the land, and the soil plowed, disced, and harrowed about November or December. From this time until just before flooding, which takes place just before planting, the soil is left fallow. The land is then flooded and as soon afterwards as possible disced and harrowed. Beds are then thrown up four to four and one-half feet apart, and eight inches high, but about half of this height is dragged off before planting. Only as much land should be irrigated at one time as can be prepared and planted by the labor and machinery available before the soil becomes too dry for germination.

Planting. — Planting is generally done some time between March 10 and April 1. One-horse or two-horse planters may be used, and one or two rows may be planted at a time. Except in very heavy soils, flat planting is usually recommended. In order that a good stand of cotton may be secured, the seed must be planted on moist soil. Early planting is advocated since late planting causes the excessive development of the vegetative branches.

Cultural Practices. — Late thinning, as well as the practice of leaving the plants close together in the row, about 12 to 14 inches, is advocated. Water should be used sparingly until the plants blossom, but frequent and light irrigations must be made between blossoming time and full maturity. Care must be taken that the water is not withheld to the extent that the plants will be severely checked between the time the bolls begin to form and the first crop. The size, vigor, and fruitfulness of Egyptian cotton is determined largely by the moisture capacity of the soil. Soils having a low moisture-holding capacity are unsuited to the production of this crop. Cultivation is continued as long as the size of the plants will permit. "Going to weed" and late bearing, due to the application of too much water, are the most frequent causes of low yield.

Alkali Resistance. — A good stand of cotton can be secured where there is less than one-half of one per cent of alkali in the first three feet

of soil. Resistant strains of cotton that will be able to withstand a high percentage of alkali will no doubt be bred in the near future.

Picking. — The bolls of the American-Egyptian cotton are smaller, three-locked, have a sharp-pointed bur, and are less perfectly opened than those of the American Upland, making the process of picking a very much harder task, particularly since the production of clean fiber is emphasized. The scarcity of labor at picking time, that presented such an obstacle in the early stages of the industry, has been overcome by importing white pickers from other cotton states, and by importing Mexicans and Indians, particularly the Indians of the Papago and Pima Reservations.

Picking should begin just as soon as there are 8 to 10 open bolls per foot of row. Picking usually begins about the middle of September but in certain localities may not begin until a month later. At least three pickings should be made and the cotton from each picking kept separate.

Ratooning. — Because of the mild winters of southern Arizona and California, the great majority of the plants will live over winter and send up new shoots in the spring. If these shoots are allowed to grow an early crop will be secured. Nevertheless, this practice, which is known as ratooning, is not to be advocated, for a perfect stand is rarely obtained. Poor results are secured from replanting the vacant places, and a poorer quality of lint is secured the second year. Furthermore, such a practice would help increase such cotton insects and diseases as infest a locality. The practice of ratooning has been tried out in Egypt and found to be unsatisfactory.

Enemies of American-Egyptian Cotton. — Boll worms, aphis, root rot, and "sore skin" are the principal insect and disease enemies that have appeared in the American-Egyptian cotton fields so far. The damage done by these has been of a minor character, and somewhat localized in its distribution.

Arizona Wild Cotton (*Thurberia thespesioides*, A. Gray). — At this point a word should be said concerning the Arizona wild cotton. The Arizona wild cotton was first described by Asa Gray in 1855. He secured his specimens from Mexico. It is a perennial shrub ranging from 2 to 14 feet in height. It is a member of the Malvaceæ family, but not of the genus *Gossypium*. It resembles cotton in appearance and habit of growth. The upper branches of the plant bear more flowers and fruits than the lower ones. The leaves are palmately cleft into three to five parts. The flowers range in color from white to pink. The bolls are one-half to one inch in diameter, and one-half to three-fourths of an inch in length. The bolls usually contain three cells, but may have four to five. The seed appear naked, but are really covered with a coat

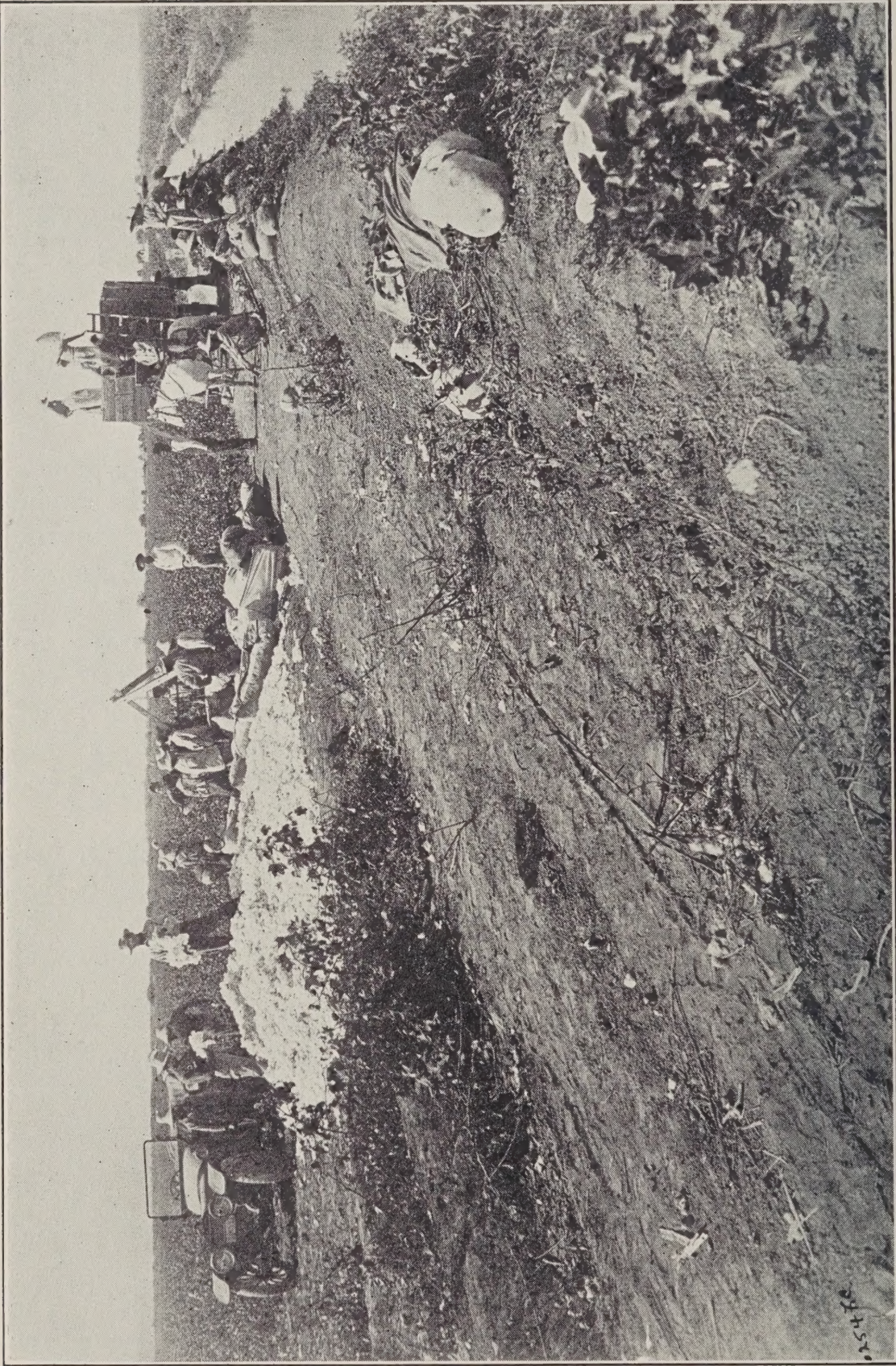


Fig. 91. — Picking American-Egyptian cotton grown under irrigation in the Imperial Valley of California. (Photograph by Underwood and Underwood, New York.)

of hairs less than a millimeter thick. On the inner wall of the boll, arranged along the edge of the valves are lines of white hairs four to five millimeters long. The flowers and stems are covered with small black glands.

Thurberia has no well defined habitat but up to the present time it has been found in this country, in New Mexico and Arizona. It occurs on dry slopes, peaks of low mountains, and in the moist beds of canyons at an elevation ranging from about 2200 feet to about 7000 feet.

Thurberia has attracted considerable attention recently because of the fact that a boll weevil similar to *Anthonomus grandis* lives upon the plant. In 1920 this weevil was found attacking cultivated cotton north of Tucson, Arizona. The State of Arizona is attempting to eradicate this infestation by establishing a non-cotton zone in the infested region.

Land Renovating Value of American-Egyptian Cotton. — The principal crop in the cotton growing irrigated region of the Southwest today



FIG. 92. — Indians picking American-Egyptian cotton. (Courtesy, U. S. Dept. of Agriculture.)

is alfalfa. The greater part of the irrigated land is sown to alfalfa, but after a few years the alfalfa becomes badly infested with Bermuda grass, and therefore unprofitable. It is in such cases that cotton as a land renovating crop has its value. By plowing such fields and planting them to cotton the Bermuda grass may be cleaned out in one or two years. As cotton requires only one-half to two-thirds as much water as alfalfa, and since there is more irrigatable land than there is water with

which to irrigate, a larger acreage of cotton than of alfalfa can be cared for with a given quantity of water. Alfalfa leaves the land in excellent condition for cotton, and in most cases a good yield of cotton is secured where alfalfa precedes it.

Use of American-Egyptian Cotton. — American-Egyptian cotton is used, as is the Egyptian cotton, in the manufacture of fabrics where strength, or fineness, or a combination of both qualities, is desired, as is the case in such articles as automobile tire fabrics, fancy dress goods, hosiery, and sewing thread.

Grades of American-Egyptian Cotton. — Up to 1919 American-Egyptian cotton was graded into five grades known as Fancy, Extra, Choice, Standard, and Medium. In January, 1919, the United States Department of Agriculture instituted the official cotton standards for American-Egyptian cotton, and numbers were substituted for the grade names: No. 1 for Fancy; No. 2 for Extra; No. 3 for Choice; No. 4 for Standard; and No. 5 for Medium. Cotton representing a grade between any two of these full grades is designated by the grade number of the higher grade, followed by " $\frac{1}{2}$." For example, cotton between grades No. 2 and No. 3 is grade No. 2 $\frac{1}{2}$. Cotton inferior to No. 5 is designated as "Below Grade 5." The length of staple is determined by actual measurements.

Comparison of the American-Egyptian Cotton Grades with the American Upland and Egyptian Cotton Grades. — The five grades of American-Egyptian may be described as follows:

1. No. 1 must be clear and clean, and of a creamy color. It corresponds to the Extra Fine Sakellaridis Egyptian, and may contain as much leaf as Strict Good Middling, United States Official Standard.

2. No. 2 must be clean, creamy or slight color. It is equivalent to the Fine Sakellaridis Egyptian, and may contain as much leaf as Good Middling, United States Official Standard.

3. No. 3 allows color after frost and is equivalent to Good Sakellaridis Egyptian and allows as much leaf as Strict Middling, United States Official Standard.

4. No. 4 is equivalent to Fully Good Fair to Good Fair Sakellaridis Egyptian, and may contain as much leaf as Middling, United States Official Standard.

5. No. 5 is equivalent to Strictly Good Fair Sakellaridis Egyptian and may contain as much leaf as Strict Low Middling, United States Official Standard.

Production of American-Egyptian Cotton since 1912. — The following table gives the number of bales of American-Egyptian cotton

produced each year since the distribution of the Yuma variety of cotton seed in 1912.

Year	Cotton lint in bales
1912.....	375
1913.....	2,135
1914.....	6,187
1915.....	1,095
1916.....	3,331
1917.....	15,966
1918.....	36,187*
1919.....	40,437
1920.....	37,094
1921.....	32,824
1922.....	22,426
1923.....	4,319

* Figures for 1912 to 1919 inclusive, in 500-pound bales; succeeding years in running bales.

Since the World War the production of American-Egyptian cotton has gradually decreased because many farmers have stopped growing the American-Egyptian and are planting Upland cotton. This condition has been brought about because large importations of cotton could be made from Egypt at a relatively low price. The price of Egyptian cotton did not advance during 1922 and 1923 in proportion to the price of Upland cotton. Furthermore, Upland cotton does very well in this section, and during some years, and in some localities, such varieties as Lone Star, Durango, Mebane, Hartsville, and especially Acala, yield just as well as Pima. It now appears that American-Egyptian cotton will have a strong competitor in Upland cotton.

REFERENCES

1. Brand, Chas. J. U. S. D. A., Bur. of Markets, S. R. A. 41, 1919.
2. Cook, O. F., and Martin, R. D. Culture of Pima and Upland cotton in Arizona. U. S. D. A., Farmers' Bul. 1432, 1924.
3. Hanson, H. C. Distribution of Arizona wild cotton. Arizona Exp. Sta., Tech. Bul. 3, 1923.
4. Kearney, T. H. A plant industry based upon mutation. Jour. of Heredity, Vol. 9, pp. 51-61, 1918.

5. Kearney, T. H., and Peterson, Wm. A. Egyptian cotton in the southwest. U. S. D. A., Bur. of Plant Industry, Bul. 128, 1908.
6. Martin, J. G. The handling and marketing of the Arizona-Egyptian cotton of the Salt River Valley. U. S. D. A., Bul. 311, 1915.
7. Scofield, C. S., *et al.* Production of American-Egyptian cotton. U. S. D. A., Bul. 742, 1919.

APPENDIX¹

TABLE I

COTTON PRODUCTION IN SPECIFIED COUNTRIES, AVERAGE 1909-10 TO 1913-14,
ANNUAL 1921-22 TO 1924-25
(Bales of 478 pounds net)

Country	Year beginning about Aug. 1				
	Average 1909-10 to 1913-14	1921-22	1922-23	1923-24	1924-25 prelimi- nary
Northern Hemisphere:					
North America:	Bales	Bales	Bales	Bales	Bales
United States ¹	13,033,235	7,953,641	9,762,069	10,139,671	13,153,000
Mexico.....	193,000	147,302	178,243	138,000	² 213,000
Total North American countries re- porting 1909-1923.....	13,226,235	8,100,943	9,940,312	10,277,671	13,366,000
Central and South America and West Indies:					
Venezuela.....	10,000	.....	.....	.....	.....
Guatemala.....	⁴ 144	215	194	125	.....
Haiti ⁵	⁸ 8,910	⁶ 21,553	⁶ 16,000	.....	.....
Dominican Republic ⁵	³ 1,066	405	374	448	.....
Porto Rico.....	⁴ 1,319	920	1,046	.....	.....
San Salvador.....	.....	.....	.....	.....	² 20,000
British West Indies:					
Montserrat.....	657	768	837	1,004	.....
St. Kitts-Nevis.....	1,347	732	879	523	.....
Grenada.....	703	534	691	.....	.....
St. Vincent.....	1,026	523	1,213	² 1,200	² 1,300
Barbadoes.....	1,061	419	832	² 837	.....
Total Central and South American countries and West Indies reporting 1909-1923.....	5,157	2,847	4,135	4,012	.....

¹ When not otherwise stated the tables included in the Appendix have been taken or compiled from the reports of the United States Departments of Commerce and Agriculture.

TABLE I. — *Continued*
COTTON PRODUCTION IN SPECIFIED COUNTRIES, AVERAGE 1909-10 TO 1913-14,
ANNUAL 1921-22 TO 1924-25
(Bales of 478 pounds net)

Country	Year beginning about Aug. 1				
	Average 1909-1910 to 1913-14	1921-22	1922-23	1923-24	1924-25 prelimi- nary
Northern Hemisphere — <i>Continued</i>					
Europe:	Bales	Bales	Bales	Bales	Bales
Italy.....	5,212	.....	4,603	5,000	.....
Yugoslavia.....	922	798	858	669	.....
Greece.....	412,614	5,986	29,868	213,250	210,800
Bulgaria.....	1,073	1,840	3,600	1,799	2,448
Malta.....	433	485	167	98	.....
Spain.....	.....	.....	694	1,088	.....
Total European countries reporting 1909-1923.....	14,120	8,311	13,635	15,147	.....
North Africa:					
Algeria.....	61,370	293	397	795	1,736
Dahomey.....	664	61,946	61,273	.....	.....
French Guinea ⁶	4230	114	172	.....	.....
Ivory Coast ⁶	428	94	109	.....	.....
French Sudan ⁶	7235	143	647	.....	.....
French Togo ⁶	72,312	4,603	4,612	.....	.....
Italian Somaliland.....	6510	95	1,192	1,757	.....
Eritrea.....	61,022	179	690	1,381	.....
Egypt.....	1,453,000	902,000	81,170,000	1,213,000	1,322,000
Anglo-Egyptian Sudan.....	12,552	19,707	23,452	40,607	45,307
Gold Coast.....	104	612	77	2837	.....
Kenya.....	519	418	460	21,004	.....
Nigeria.....	9,050	13,578	16,388	.....	.....
Uganda.....	20,338	31,381	77,678	94,142	.....
Total African countries reporting 1909-1923.....	1,486,513	953,518	1,271,667	1,349,590	.....

TABLE I. — *Continued*

COTTON PRODUCTION IN SPECIFIED COUNTRIES, AVERAGE 1909-10 TO 1913-14,
ANNUAL 1921-22 TO 1924-25
(Bales of 478 pounds net)

Country	Year beginning about Aug. 1				
	Average 1909-1910 to 1913-14	1921-22	1922-23	1923-24	1924-25 prelimi- nary
<i>Northern Hemisphere — Continued</i>					
Asia:	Bales	Bales	Bales	Bales	Bales
Cyprus.....	1,938	1,444	1,276	1,674	.....
Turkey, Asiatic.....	133,000	230,000	250,000	260,000	.....
India ⁹	3,585,000	3,753,000	4,247,000	4,247,000	5,069,000
Ceylon.....	417	157	189	189	.....
Iraq.....	.....	241	830	3,138	.....
Russia, Asiatic.....	953,000	43,000	55,000	2321,000	438,000
Persia.....	136,000	.....	.....	.....	.....
China ¹⁰	3,473,000	1,517,000	2,318,000	1,785,000	1,952,000
Japanese Empire:					
Japan.....	4,704	3,447	2,028	.....	.....
Chosen (Korea).....	717,387	92,448	103,347	111,088	119,602
French Indo-China.....	14,337	11,665	11,088	.....	.....
Siam.....	23,653	3,648	4,965	.....	.....
North Borneo ⁶	125	112	222	195	.....
Total Asiatic countries reporting 1909-1923.....	8,030,467	5,407,161	6,725,034	6,466,146	.....
Total northern hemisphere countries reporting 1909-1923.....	22,762,492	14,472,780	17,954,783	18,112,566	.....
Southern Hemisphere:					
Peru.....	110,000	182,410	187,032	197,000	.....
Ecuador.....	.....	23,606	24,311	211,080	217,400
Brazil.....	2322,000	505,000	552,857	719,000	.....
Paraguay.....	.....	2,610	25,803	16,260	228,000
Argentina.....	23,045	17,282	26,892	73,703	.....
Belgian Congo.....	.....	4,520	4,603	26,800	.....
Tanganyika Territory.....	7,971	6,132	6,004	8,400	.....
Nyasaland.....	4,536	3,285	4,601	2,322	.....
Union of South Africa.....	76	1,778	3,138	25,021	.....
Angola.....	510	2,067	.....	.....	.....

TABLE I. — *Continued*
 COTTON PRODUCTION IN SPECIFIED COUNTRIES, AVERAGE 1909-10 TO 1913-14,
 ANNUAL 1921-22 TO 1924-25
 (Bales of 478 pounds net)

Country	Year beginning about Aug. 1				
	Average 1909-1910 to 1913-14	1921-22	1922-23	1923-24	1924-25 prelimi- nary
<i>Southern Hemisphere — Continued</i>					
	Bales	Bales	Bales	Bales	Bales
Mozambique.....	6766	1,041	2,200	6,248	.....
Dutch East Indies.....	13,981	12,333	.....	.....	.....
New Hebrides ⁴	6303	3,124	2,812	1,828	.....
Australia.....	91	2,720	7,531	8,787	.....
Total Southern Hemisphere countries reporting 1909-1923.....	448,788	722,772	793,067	1,022,309	.....
Total all countries reporting 1909- 1923.....	23,211,280	15,195,552	18,747,850	19,134,875	.....
Estimated world total.....	23,580,000	15,330,000	18,900,000	19,300,000	.....

¹ Linters not included.
² From an unofficial source.
³ Average for three years.
⁴ For one year.
⁵ Average for three years.
⁶ Exports.
⁷ Average for four years.
⁸ The official estimate is 1,015,000 bales, but receipts into Alexandria and exports indicate a larger crop.
⁹ The commercial crop of India, according to figures compiled by the United States Department of Commerce, was 3,448,000 bales in 1921-22, 4,048,000 bales in 1922-23, and 3,811,000 bales in 1923-24.
¹⁰ Chinese Economic Bulletin quoting the Chinese Cotton Mill Owners Association, which represents the most important cotton producing provinces where the commercial crop is grown. Cotton grown in other provinces is used for home hand-loom consumption. Various estimates made from time to time of the total production of China range from 2,000,000 to 7,000,000 bales, but are considered unreliable. The commercial crop for China, according to figures compiled by the United States Department of Commerce, was 1,175,000 bales for 1921-22, 1,300,000 bales for 1922-23, and 1,450,000 bales for 1923-24.
Division of Statistical and Historical Research. — Official sources and International Institute of Agriculture except as otherwise stated. Data for crop year, as given at the head of the table, are for crops harvested between about August 1 and July 31 of the following year. This applies to both Northern and Southern Hemispheres. For the United States prior to 1914 the figures apply to the year beginning September 1.

TABLE II
COTTON — WORLD PRODUCTION 1900-1924

Year beginning about August 1	Estimated world totals	Three principal producing countries		
		United States	India	Egypt
	Bales	Bales	Bales	Bales
1924.....	.....	13,153,000	5,069,000	1,322,000
1923.....	19,300,000	10,128,478	4,247,000	1,213,000
1922.....	18,900,000	9,762,069	4,247,000	1,170,000
1921.....	15,330,000	7,953,641	3,753,000	902,000
1920.....	20,875,000	13,439,603	3,013,000	1,251,000
1919.....	21,384,000	11,420,763	4,853,000	1,155,000
1918.....	20,613,000	12,040,532	3,328,000	999,000
1917.....	19,675,000	11,302,375	3,393,000	1,304,000
1916.....	19,845,000	11,449,930	3,759,000	1,048,000
1915.....	20,689,000	11,191,820	3,128,000	989,000
1914.....	28,687,000	16,134,930	4,359,000	1,337,000
1913.....	26,259,000	14,156,486	4,239,000	1,588,000
1912.....	25,043,000	13,703,421	3,702,000	1,554,000
1911.....	25,356,000	15,692,701	2,730,000	1,530,000
1910.....	21,915,000	11,608,616	3,254,000	1,555,000
1909.....	19,329,000	10,004,949	3,998,000	1,036,000
1908.....	21,267,000	13,241,799	3,090,000	1,399,000
1907.....	17,458,000	11,107,179	2,613,000	1,499,000
1906.....	21,357,000	13,273,809	4,129,000	1,440,000
1905.....	16,925,000	10,575,017	2,859,000	1,235,000
1904.....	20,079,000	13,438,012	3,172,000	1,308,000
1903.....	16,253,000	9,851,129	2,645,000	1,349,000
1902.....	16,948,000	10,630,945	2,818,000	1,210,000
1901.....	15,292,000	9,509,745	2,297,000	1,320,000
1900.....	15,931,000	10,123,027	2,471,000	1,126,000

Division of Statistical and Historical Research. Bales of 478 pounds net. Data for crop year as given are for crops harvested between August 1 and July 31 of the following year. This applies to both Northern and Southern Hemispheres. For the United States prior to 1914 the figures apply to the year beginning September 1.

TABLE III
COTTON PRODUCTION BY STATES FOR SELECTED YEARS: 1839 TO 1923*

Growth Year	United States	Alabama	Arkansas	Florida	Georgia	Louisiana	Mississippi	Missouri ¹	North Carolina
1923	10,170,694	599,140	643,643	13,628	612,812	373,812	622,617	292,345	1,053,402
1922	9,729,306	819,870	1,010,520	27,428	735,874	345,407	985,787	232,030	879,294
1921	7,977,778	587,669	788,047	12,202	822,621	284,330	816,961	154,617	803,620
1920	13,270,970	670,330	1,182,010	19,443	1,447,159	389,569	900,371	272,709	949,484
1919	11,325,532	716,655	867,177	17,317	1,678,758	303,035	950,907	185,156	857,253
1918	11,906,480	789,265	957,118	34,951	2,117,860	582,698	1,193,122	191,719	919,338
1917	11,248,242	520,906	953,587	48,178	1,885,054	629,719	886,269	144,709	656,656
1916	11,463,915	552,679	1,102,671	50,979	1,852,104	441,121	800,190	117,550	793,672
1915	11,068,173	1,025,818	789,583	55,354	1,937,730	336,813	925,509	82,192	737,354
1914	15,905,840	1,731,751	999,237	90,648	2,723,094	452,261	1,217,883	140,109	970,479
1913	13,982,811	1,483,669	1,038,293	66,700	2,346,237	436,865	1,251,841	95,629	837,995
1912	13,488,539	1,328,297	770,937	58,833	1,812,778	374,793	1,004,376	64,573	906,351
1911	15,553,073	1,695,284	908,014	94,471	2,794,295	380,826	1,169,066	107,879	1,126,276
1910	11,568,334	1,192,179	798,156	67,172	1,812,178	246,788	1,212,104	68,694	753,087
1909	10,072,731	1,040,137	697,603	61,877	1,850,125	258,459	1,073,105	146,785	633,746
1908	13,086,005	1,332,003	996,093	70,598	1,977,050	466,543	1,620,325	60,025	683,628
1907	11,057,822	1,113,093	751,851	56,668	1,860,323	662,032	1,442,881	36,415	637,961
1906	12,983,201	1,241,133	894,268	61,473	1,632,703	955,473	1,483,408	53,684	611,258
1905	10,495,105	1,228,000	598,915	78,838	1,725,272	511,738	1,168,059	41,664	652,815
1904	13,451,337	1,451,362	901,223	87,525	1,962,890	1,083,683	1,774,464	51,434	749,712
1903	9,819,969	987,224	715,588	58,572	1,305,844	818,087	1,410,805	36,839	555,320
1902	10,588,250	965,518	949,101	67,287	1,475,834	866,911	1,423,395	42,289	567,530
1901	9,582,520	1,112,892	712,492	57,144	1,373,857	834,048	1,252,728	29,951	450,128
1900	10,102,102	1,028,640	801,034	55,696	1,256,901	705,061	1,037,029	27,130	508,302
1899	9,393,242	1,086,667	702,512	56,821	1,287,386	701,662	1,239,373	19,582	472,770
1898	11,189,205	1,176,042	919,469	35,064	1,378,731	717,747	1,247,128	33,207	629,620
1897	10,897,857	1,112,681	942,267	53,657	1,350,781	788,325	1,524,771	27,082	646,726
1896	8,532,705	833,789	605,643	48,730	1,299,340	567,251	1,201,000	24,717	521,795
1895	7,161,094	663,916	520,860	38,722	1,067,377	513,843	1,013,358	11,934	397,752
1894	9,901,251	900,439	748,206	50,729	1,247,952	760,757	1,231,227	25,543	479,441
1889	7,472,511	915,210	691,494	57,928	1,191,846	659,180	1,154,725	16,941	336,261
1884	5,682,000	648,700	531,400	57,300	807,400	485,200	883,200	30,200	404,100
1879	5,755,359	699,654	608,256	54,997	814,441	508,569	963,111	21,685	389,598
1869 ⁴	3,011,996	429,482	247,968	39,789	473,934	350,832	564,938	2,965	144,935
1859 ⁴	5,387,052	989,955	367,393	65,153	701,840	777,738	1,202,507	42,886	145,514
1849 ⁴	2,469,093	564,429	65,344	45,131	499,091	178,737	484,292	772	73,845
1839 ⁴	2,063,915	305,846	15,741	31,620	426,612	398,317	504,965	2,662	135,578

TABLE III. — *Continued*

COTTON PRODUCTION BY STATES FOR SELECTED YEARS: 1839 TO 1923*

Growth Year	United States	Oklahoma	South Carolina	Tennessee	Texas	Virginia	Arizona	California
1923	10,170,694	665,904	793,817	235,344	4,212,248	51,982	77,704	55,313
1922	9,729,306	637,003	517,464	385,860	3,125,758	27,011	44,132	28,473
1921	7,977,778	477,777	786,039	297,555	2,129,660	16,680	42,926	34,809
1920	13,270,970	1,302,610	1,652,177	314,811	4,148,399	21,898	105,191	77,892
1919	11,325,532	1,002,178	1,462,277	301,408	2,960,335	23,076	58,472	59,082
1918	11,906,480	585,149	1,581,726	317,962	2,610,337	25,235	54,215	71,479
1917	11,248,242	955,342	1,267,135	238,806	3,041,726	20,155	21,140	58,974
1916	11,463,915	813,419	970,702	378,064	3,562,789	27,975	.....	43,664
1915	11,068,173	622,176	1,174,213	296,222	3,068,852	16,357	.....	28,586
1914	15,905,840	1,232,638	1,560,195	372,068	4,390,200	25,277	.....	48,374
1913	13,982,811	842,499	1,418,704	366,786	3,773,024	24,569	.....	22,411
1912	13,488,539	1,005,109	1,224,245	267,439	4,645,309	25,499	.....	7,934
1911	15,553,073	1,016,538	1,692,146	430,027	4,107,152	31,099	.....	.....
1910	11,568,334	919,842	1,210,968	321,103	2,949,968	16,095	.....	.....
1909	10,072,731	552,678	1,137,382	240,757	2,469,331	10,746	.....	.....
1908	13,086,005	689,345	1,215,848	334,084	3,627,350	13,113	.....	.....
1907	11,057,822	848,977	1,163,565	266,433	2,208,021	9,602	.....	.....
1906	12,983,201	871,961	912,602	293,023	3,957,619	14,596	.....	.....
1905	10,495,105	660,027	1,112,363	269,030	2,432,718	15,666	.....	.....
1904	13,451,337	796,382	1,192,926	320,317	3,062,203	17,216	.....	.....
1903	9,819,969	456,704	814,351	240,808	2,406,146	13,681	.....	.....
1902	10,588,250	530,709	948,005	307,102	2,427,994	16,575	.....	.....
1901	9,582,520	371,029	731,561	194,847	2,447,834	14,009	.....	.....
1900	10,102,102	346,237	779,849	215,375	3,329,015	11,833	.....	.....
1899	9,393,242	209,611	874,744	207,551	2,525,324	9,239	.....	.....
1898	11,189,205	316,864	1,035,414	322,820	3,363,109	13,990	.....	.....
1897	10,897,857	317,561	1,030,085	268,635	2,822,408	12,878	.....	.....
1896	8,532,705	122,956	936,463	236,781	2,122,701	11,539	.....	.....
1895	7,161,094	82,771	764,700	172,560	1,905,337	7,664	.....	.....
1894	9,901,251	135,566	862,604	304,981	3,140,392	13,414	.....	.....
1889	7,472,511	34,540	747,190	190,579	1,471,242	5,375	.....	.....
1884	5,682,000	(²)	511,800	313,800	995,400	13,500	.....	.....
1879	5,755,359	17,000	522,548	320,621	805,284	19,565	.....	.....
1869 ³	3,011,996	.....	224,500	181,842	350,628	183	.....	.....
1859 ³	5,387,052	.....	353,412	296,464	431,463	12,727	.....	.....
1849 ³	2,469,093	.....	300,901	194,532	58,072	3,947	.....	.....
1839 ²	2,063,915	.....	161,123	72,327	.....	9,124	.....	.....

* Quantities are given in running bales, except that round bales are counted as half bales. Linters are excluded. The statistics of production for the census years 1879, 1889, 1909, are census figures based on actual canvass, while the others are as estimated by the United States Department of Agriculture.

¹ Includes statistics for other cotton-producing localities not named; also for Oklahoma and Virginia in 1893 and for Oklahoma in 1884.

² Included with Missouri.

³ The statistics of bales for 1849, 1859 and 1869 are equivalent 400-pound bales, as expressed in the census reports for those years; those for 1839 are in equivalent bales of 383 pounds, net weight.

TABLE IV
COTTON (LINTERS): PRODUCTION, UNITED STATES 1899-1923

Year beginning August	Production, in 500-lb. gross weight bales	Year beginning August	Production, in 500-lb. gross weight bales
1923.....	668,600	1910.....	397,072
1922.....	607,779	1909.....	310,433
1921.....	397,752	1908.....	345,507
1920.....	440,313	1907.....	268,282
1919.....	607,964	1906.....	321,689
1918.....	929,516	1905.....	229,539
1917.....	1,125,719	1904.....	241,942
1916.....	1,330,714	1903.....	194,486
1915.....	931,141	1902.....	196,223
1914.....	856,900	1901.....	166,026
1913.....	638,881	1900.....	143,500
1912.....	609,594	1899.....	114,544
1911.....	557,575		

Division of Crop and Livestock Estimates. Compiled from reports of the Bureau of Census.

TABLE V
PRODUCTION OF SEA ISLAND AND AMERICAN-EGYPTIAN COTTON IN THE UNITED STATES FOR THE YEARS 1900-1924, INCLUSIVE

Year	Sea Island ¹	American- Egyptian ²	Year	Sea Island ¹	American- Egyptian ²
1924.....	11	4,319	1911.....	119,293	.....
1923.....	785	22,426	1910.....	90,368	.....
1922.....	5,125	32,824	1909.....	94,791	.....
1921.....	3,327	37,094	1908.....	93,858	.....
1920.....	1,868	92,561	1907.....	86,895	.....
1919.....	6,916	40,437	1906.....	57,550	.....
1918.....	52,208	36,187	1905.....	112,539	.....
1917.....	92,619	15,966	1904.....	104,317	.....
1916.....	117,559	3,331	1903.....	75,393	.....
1915.....	91,844	1,095	1902.....	104,953	.....
1914.....	81,654	6,187	1901.....	77,879	.....
1913.....	77,563	2,135	1900.....	88,294	.....
1912.....	73,777	375			

¹ Running bales.

² Figures for 1912 to 1917, inclusive, in 500-pound bales; succeeding years in running bales.

TABLE VI
COTTON: ACREAGE AND YIELD PER ACRE IN SPECIFIED COUNTRIES, AVERAGE 1909-10 TO 1913-14, ANNUAL 1921-22 TO 1924-25*
(Year beginning about August 1)

Country	Acreage					Average yield per acre				
	Average 1909-10 to 1913-14	1921-22	1922-23	1923-24	1924-25	Average 1909-10 to 1913-14	1921-22	1922-23	1923-24	1924-25
	1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	Pounds	Pounds	Pounds	Pounds	Pounds
United States.....	34,152	30,509	33,036	37,123	140,115	182	125	141	131	157
India.....	22,503	18,451	21,792	23,088	224,707	76	97	93	88	...
Egypt.....	1,743	1,341	1,868	1,649	1,856	398	315	299	352	317
China ³.....	.....	4,284	3,947	.....	.....	...	...	...	...	...
Brazil.....	⁴ 504	1,420	1,512	1,966	.....	...	170	175	175	...
Russia (Asiatic).....	1,490	296	174	557	⁵ 1,196	306	74	70	...	...
Mexico.....	⁶ 245	230	242	⁵ 279	⁵ 511	...	...	...	...	...
Chosen (Korea).....	⁶ 146	362	370	378	408	57	122	133	140	...
Uganda.....	58	170	334	419	⁵ 578	169	88	111	107	...
Peru.....	⁷ 163	283	291	⁵ 320	⁵ 352	...	...	...	...	...
Anglo-Egyptian Sudan.....	44	84	62	101	.....	136	112	181	192	...
Argentina.....	6	39	56	155	⁵ 225	243	200	230	227	...
Total countries reporting 1909-1923.....	61,054	53,185	59,737	66,035	.....	...	...	...	...	...
Estimated world total.....	67,300	58,400	64,600	71,000	76,000	...	...	...	...	...

* Division of Statistical and Historical Research. Official sources and International Institute of Agriculture except as otherwise stated. Data for crop year as given at the head of the table are for crops harvested between about Aug. 1 and July 31 of the following year. This applies to both Northern and Southern Hemispheres. For the United States prior to 1914 the figures apply to the year beginning Sept. 1.

¹ Estimate of area planted; for other years area harvested.

² Third estimate. In the past 12 years the third estimate has averaged 95 per cent of the final estimate.

³ Chinese Economic Bulletin quoting the Chinese Cotton Mill Owners' Association which represents the most important cotton growing area where the commercial crop is grown.

⁴ For the year 1915-16.

⁵ From an unofficial source.

⁶ Average for four years.

⁷ Average for 1914-15 to 1918-19.

TABLE VII
COTTON ACREAGE HARVESTED BY STATES FOR SELECTED YEARS: 1879 TO 1924*

Growth Year	United States	Alabama	Arkansas	Florida	Georgia	Louisiana	Missis- sippi	Missouri ¹
1924 ²	40,403,000	3,190,000	3,058,000	111,000	3,767,000	1,537,000	3,256,000	934,000
1923	37,122,000	3,079,000	3,026,000	147,000	3,421,000	1,405,000	3,170,000	637,000
1922	33,036,000	2,771,000	2,799,000	118,000	3,418,000	1,140,000	3,014,000	410,000
1921	30,509,000	2,235,000	2,382,000	65,000	4,172,000	1,168,000	2,628,000	266,000
1920	35,878,000	2,858,000	2,980,000	100,000	4,900,000	1,470,000	2,950,000	540,000
1919	33,566,000	2,791,000	2,725,000	103,000	5,220,000	1,527,000	2,848,000	327,000
1918	36,008,000	2,570,000	2,991,000	167,000	5,341,000	1,683,000	3,138,000	340,000
1917	33,841,000	1,977,000	2,740,000	183,000	5,195,000	1,454,000	2,788,000	345,000
1916	34,985,000	3,225,000	2,600,000	191,000	5,277,000	1,250,000	3,110,000	210,000
1915	31,412,000	3,340,000	2,170,000	193,000	4,825,000	990,000	2,735,000	150,000
1914	36,832,000	4,007,000	2,480,000	221,000	5,433,000	1,299,000	3,054,000	212,000
1913	37,089,000	3,760,000	2,502,000	188,000	5,318,000	1,244,000	3,067,000	126,000
1912	34,283,000	3,730,000	1,991,000	224,000	5,335,000	929,000	2,889,000	112,000
1911	36,045,000	4,017,000	2,363,000	308,000	5,504,000	1,075,000	3,340,000	141,000
1910	32,403,000	3,560,000	2,238,000	257,000	4,873,000	975,000	3,317,000	109,000
1909	32,044,000	3,731,000	2,153,000	263,000	4,883,000	957,000	3,400,000	106,000
1908	32,444,000	3,591,000	2,296,000	265,000	4,848,000	1,550,000	3,395,000	87,000
1907	29,660,000	3,148,000	1,902,000	209,000	4,566,000	1,540,000	3,081,000	63,000
1906	31,374,000	3,658,000	2,097,000	283,000	4,610,000	1,739,000	3,408,000	91,000
1905	27,110,000	3,425,000	1,723,000	230,000	4,020,000	1,445,000	3,019,000	70,000
1904	31,215,000	3,804,000	2,173,000	272,000	4,397,000	1,967,000	3,911,000	92,000
1903	27,052,000	2,931,000	1,796,000	178,000	3,834,000	1,772,000	3,250,000	78,000
1902	27,175,000	3,178,000	1,735,000	237,000	4,129,000	1,613,000	3,141,000	58,000
1901	26,774,000	3,377,000	1,988,000	206,000	3,762,000	1,547,000	2,929,000	76,000
1900	24,933,000	3,244,000	1,746,000	176,000	3,342,000	1,442,000	3,150,000	49,000
1899	24,275,101	3,202,135	1,641,855	221,825	3,513,839	1,376,254	2,897,920	48,201
1898	24,967,295	3,003,176	1,876,467	152,452	3,535,205	1,281,691	2,900,298	82,498
1897	24,319,584	2,709,460	1,619,785	251,109	3,537,702	1,245,399	2,778,610	83,784
1896	23,273,209	2,656,333	1,542,652	264,325	3,468,335	1,245,399	2,835,316	79,373
1895	20,184,808	2,371,726	1,186,655	191,540	3,069,323	1,142,568	2,487,119	48,212
1894	23,687,950	2,664,861	1,483,319	201,621	3,610,968	1,313,296	2,826,272	72,107
1889	20,175,270	2,761,165	1,700,578	227,370	3,345,104	1,270,154	2,883,278	60,620
1884	17,439,612	2,740,941	1,259,858	268,111	2,958,930	922,581	2,392,447	70,920
1879	14,480,019	2,330,086	1,042,976	245,595	2,617,138	864,787	2,106,215	34,783

TABLE VII. — *Continued*

COTTON ACREAGE HARVESTED BY STATES FOR SELECTED YEARS: 1879 TO 1924

Growth Year	United States	North Carolina	Oklahoma	South Carolina	Tennessee	Texas	Virginia
1924 ²	40,403,000	1,822,000	3,672,000	2,185,000	1,184,000	15,595,000	92,000
1923	37,122,000	1,679,000	3,197,000	1,965,000	1,172,000	14,150,000	74,000
1922	33,036,000	1,625,000	2,915,000	1,912,000	985,000	11,874,000	55,000
1921	30,509,000	1,403,000	2,206,000	2,571,000	634,000	10,745,000	34,000
1920	35,878,000	1,587,000	2,749,000	2,964,000	840,000	11,898,000	42,000
1919	33,566,000	1,490,000	2,424,000	2,835,000	758,000	10,476,000	42,000
1918	36,008,000	1,600,000	2,998,000	3,001,000	902,000	11,233,000	44,000
1917	33,841,000	1,515,000	2,783,000	2,837,000	882,000	11,092,000	50,000
1916	34,985,000	1,451,000	2,562,000	2,780,000	887,000	11,400,000	42,000
1915	31,412,000	1,282,000	1,895,000	2,516,000	772,000	10,510,000	34,000
1914	36,832,000	1,527,000	2,847,000	2,861,000	915,000	11,931,000	45,000
1913	37,089,000	1,576,000	3,009,000	2,790,000	865,000	12,597,000	47,000
1912	34,283,000	1,545,000	2,665,000	2,695,000	783,000	11,338,000	47,000
1911	36,045,000	1,624,000	3,050,000	2,800,000	837,000	10,943,000	43,000
1910	32,403,000	1,478,000	2,204,000	2,534,000	765,000	10,060,000	33,000
1909	32,044,000	1,274,000	1,977,000	2,557,000	788,000	9,930,000	25,000
1908	32,444,000	1,458,000	2,311,000	2,545,000	754,000	9,316,000	28,000
1907	29,660,000	1,408,000	2,064,000	2,485,000	693,000	8,478,000	23,000
1906	31,374,000	1,374,000	1,981,000	2,389,000	814,000	8,894,000	36,000
1905	27,110,000	1,230,000	1,509,000	2,340,000	629,000	7,432,000	38,000
1904	31,215,000	1,439,000	1,553,000	2,556,000	780,000	8,233,000	38,000
1903	27,052,000	1,201,000	981,000	2,112,000	597,000	8,287,000	35,000
1902	27,175,000	1,111,000	1,022,000	2,221,000	604,000	8,096,000	30,000
1901	26,774,000	1,395,000	880,000	2,341,000	694,000	7,545,000	35,000
1900	24,933,000	1,143,000	574,000	2,140,000	600,000	7,298,000	29,000
1899	24,275,101	1,007,020	682,743	2,074,081	623,137	6,960,367	25,724
1898	24,967,295	1,311,708	530,799	2,353,213	896,722	6,991,904	51,162
1897	24,319,584	1,302,437	534,656	2,074,778	967,077	7,164,175	50,612
1896	23,273,209	1,228,714	219,674	2,014,348	912,337	6,758,656	47,747
1895	20,184,808	1,050,183	238,940	1,814,728	712,763	5,826,428	44,623
1894	23,687,950	1,296,522	262,890	2,160,391	879,954	6,854,621	61,128
1889	20,175,270	1,147,136	71,187	1,987,469	747,471	3,934,525	39,213
1884	17,439,612	1,061,048	(³)	1,716,128	815,678	3,186,668	46,302
1879	14,480,019	893,153	35,000	1,364,249	722,562	2,178,435	45,040

* Census statistics for acreage prior to 1879 are not available. The statistics of acreage for the census years 1879, 1889 and 1909, are census figures based on actual canvass, while the others are estimated by the United States Department of Agriculture.

¹ Includes statistics for other cotton-producing localities not named; also for Oklahoma and Virginia in 1893 and for Oklahoma in 1884.

² The data for 1924 relate to acreage planted.

³ Included with Missouri.

TABLE VIII
COTTON: ANNUAL YIELD PER ACRE, BY STATES, 1910-1924, AND AVERAGE YIELD PER ACRE FOR SELECTED TEN-YEAR PERIODS

Year	Va.	N. C.	S. C.	Ga.	Fla.	Ala.	Miss.	La.	Tex.	Ark.	Tenn.	Mo.	Okla.	Calif.	Ariz.	N.M.	United States
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1924.....	161	192	160	150	130	154	172	147	141	167	160	170	183	261	260	245	156.8
1923.....	325	290	187	82	40	91	91	125	147	98	92	171	98	285	292	230	130.6
1922.....	230	250	123	100	102	142	157	144	130	173	190	360	103	188	222	...	141.3
1921.....	230	264	140	90	80	124	148	114	98	160	228	325	104	258	242	...	124.5
1920.....	230	275	260	138	86	111	145	126	174	195	185	275	230	266	224	...	178.4
1919.....	255	266	240	152	74	122	160	93	140	155	195	257	195	268	270	...	161.5
1918.....	270	268	250	190	85	149	187	167	115	158	175	200	92	270	280	...	159.6
1917.....	180	194	208	173	100	125	155	210	135	170	206	190	165	242	285	...	159.7
1916.....	310	215	160	165	105	79	125	170	157	209	206	225	154	400	...	...	156.6
1915.....	225	260	215	189	120	146	167	165	147	180	188	240	162	380	...	...	170.3
1914.....	265	290	255	239	175	209	195	165	184	196	200	270	212	500	...	...	209.2
1913.....	240	239	235	208	150	190	204	170	150	205	210	286	132	500	...	...	182.0
1912.....	250	267	209	159	113	172	173	193	206	190	169	260	183	450	...	...	190.9
1911.....	330	315	280	240	130	204	172	170	186	190	257	360	160	390	...	...	207.7
1910.....	212	227	216	173	110	160	182	120	145	175	207	285	200	335	...	...	170.7
Average 1909-1900...	197	209	194	180	123	162	204	217	170	202	192	279	216	...	...	...	184.7
Average 1899-1890...	155	182	170	156	108	155	188	222	188	208	165	195	211	...	...	...	178.1
Average 1889-1880...	157	166	154	146	109	143	181	215	187	213	167	170	...	...	...	...	169.4
Average 1879-1870...	175	167	159	152	113	149	176	195	211	213	189	214	...	...	...	...	176.5

TABLE IX
WORLD'S CONSUMPTION OF COTTON, SEASONS OF 1919-20 TO 1923-24

Country	Mill consumption of cotton (bales of 478 pounds lint except American, which are in running bales)				
	1923-24	1922-23	1921-22	1920-21	1919-20
Total.....	19,982,000	21,325,000	19,990,000	16,905,000	19,300,000
United States (Exclusive of linters).....	5,681,000	6,666,000	5,910,000	4,905,000	6,485,000
Europe:					
United Kingdom.....	2,842,000	2,825,000	2,900,000	2,135,000	3,870,000
Continent.....	5,551,000	5,304,000	5,016,000	4,600,000	3,830,000
India.....	1,630,000	1,751,000	1,871,000	1,925,000	1,720,000
Japan.....	2,037,000	2,348,000	2,176,000	1,885,000	1,910,000
Canada.....	152,000	203,000	205,000	155,000	230,000
All other countries.....	2,089,000	2,228,000	1,912,000	1,300,000	1,255,000

TABLE X
PRODUCTION, CONSUMPTION, EXPORTS AND NET IMPORTS OF RAW COTTON,
FOR THE UNITED STATES 1790-1923* §

Year	Cotton production (including linters)		Consumption of cotton and linters (equivalent 500-pound bales) ¹	Exports of domestic cotton (equivalent 500-pound bales)	Net imports (equivalent 500-pound bales)
	Equivalent 500-pound bales, gross weight	Average price per pound Upland cotton (cents)			
1923.....	10,808,271	28.7	6,225,000	5,935,535	272,179
1922.....	10,369,848	22.9	7,350,000	5,049,225	449,783
1921.....	8,351,393	16.9	6,560,000	6,479,188	351,921
1920.....	13,879,916	15.8	5,477,908	6,025,915	210,606
1919.....	12,028,732	35.4	6,807,817	6,760,887	682,911
1918.....	12,970,048	28.8	6,288,922	5,843,307	197,201
1917.....	12,428,094	27.1	7,555,191	4,587,000	217,381
1916.....	12,780,644	17.3	7,721,354	5,963,682	288,486
1915.....	12,122,961	11.2	7,326,598	6,405,993	420,995
1914.....	16,991,830	7.3	6,087,338	8,931,253	363,595
1913.....	14,795,367	12.5	5,942,808	9,256,028	265,646
1912.....	14,313,015	11.5	5,867,431	9,199,093	225,460
1911.....	16,250,276	9.6	5,400,005	11,081,332	229,268
1910.....	12,005,688	14.0	4,713,126	8,025,991	231,191
1909.....	10,315,382	14.3	4,759,364	6,491,843	151,395
1908.....	13,587,306	9.2	5,198,963	8,889,724	165,451
1907.....	11,375,461	11.5	4,493,028	7,779,508	140,869
1906.....	13,595,498	10.0	4,974,199	8,825,236	202,733
1905.....	10,804,556	10.9	4,877,465	6,975,494	133,464
1904.....	13,679,954	8.7	4,523,208	9,057,397	130,182
1903.....	10,045,615	12.2	3,980,567	6,233,682	100,298
1902.....	10,827,168	8.2	4,187,076	6,913,506	149,113
1901.....	9,675,771	8.1	4,080,287	6,870,313	190,080
1900.....	10,266,527	9.3	3,603,516	6,806,572	116,610
1899.....	9,459,935	7.6	3,687,253	6,167,623	134,778
1898.....	11,435,368	4.9	3,672,097	7,626,525	103,223
1897.....	10,985,040	5.6	3,472,398	7,811,031	105,802
1896.....	8,515,640	7.3	2,841,394	6,124,026	114,712
1895.....	7,146,772	8.2	2,499,731	4,761,505	112,001
1894.....	10,025,534	5.9	2,983,665	6,961,372	99,399
1893.....	7,433,056	7.5	2,300,276	5,307,295	59,405
1892.....	6,658,313	8.4	2,415,875	4,485,251	85,735
1891.....	8,940,867	7.3	2,846,753	5,896,800	64,394
1890.....	8,562,089	8.6	2,604,491	5,850,219	45,580
1889.....	7,472,511	11.5	2,518,409	4,928,921	18,334
1888.....	6,923,775	10.7	2,309,250	4,730,192	15,284
1887.....	6,884,667	10.3	2,205,302	4,519,254	11,983
1886.....	6,314,561	10.3	2,049,687	4,301,542	7,552
1885.....	6,369,341	9.4	2,094,682	4,200,651	8,270
1884.....	5,477,448	10.5	1,687,108	3,783,319	7,144
1883.....	5,521,963	10.6	1,813,865	3,733,369	11,247
1882.....	6,833,442	10.6	2,038,400	4,591,331	4,716
1881.....	5,136,447	12.2	1,849,457	3,376,521	3,261
1880.....	6,356,998	11.3	1,865,922	4,453,495	5,447
1879.....	5,466,387	12.0	1,500,688	3,742,752	7,578
1878.....	4,745,078	10.8	1,457,266	3,290,167	5,049

TABLE X. — *Continued*

PRODUCTION, CONSUMPTION, EXPORTS AND NET IMPORTS OF RAW COTTON,
FOR THE UNITED STATES 1790-1923

Year	Cotton production (including linters)		Consumption of cotton and linters (equivalent 500-pound bales) ¹	Exports of domestic cotton (equivalent 500-pound bales)	Net imports (equivalent 500-pound bales)
	Equivalent 500-pound bales, gross weight	Average price per pound Upland cotton (cents)			
1877.....	4,494,224	11.3	1,458,667	3,197,439	5,046
1876.....	4,118,390	11.7	1,314,489	2,839,418	4,832
1875.....	4,302,818	13.0	1,255,712	3,037,650	4,498
1874.....	3,528,276	15.0	1,098,163	2,504,118	3,784
1873.....	3,873,750	17.0	1,213,052	2,682,631	3,541
1872.....	3,650,932	18.2	1,115,691	2,470,590	10,016
1871.....	2,756,564	20.5	1,146,730	1,824,937	6,374
1870.....	4,024,527	17.0	1,026,583	2,922,757	1,802
1869.....	2,409,597	24.0	796,616	1,987,708	3,026
1868.....	2,198,141	29.0	860,481	1,300,449	1,870
1867.....	2,345,610	24.9	844,044	1,502,756	345
1866.....	1,948,077	31.6	715,258	1,401,697	² 1,035
1865.....	2,093,658	43.2	614,540	1,301,146	10,322
1864.....	299,372	83.4	344,278	17,789	68,798
1863.....	449,059	101.5	219,540	23,988	52,405
1862.....	1,596,653	67.2	287,397	22,770	67,695
1861.....	4,490,586	31.3	369,226	10,129	61,731
1860.....	3,841,416	13.0	841,975	615,032	.....
1859.....	4,309,642	11.0	845,410	3,535,373	.....
1858.....	3,758,273	12.1	867,489	2,772,937	.....
1857.....	3,012,016	12.2	550,708	2,237,248	.....
1856.....	2,873,680	13.5	761,614	2,096,565	1,678
1855.....	3,220,782	10.3	731,484	2,702,863	2,295
1854.....	2,708,082	10.4	641,391	2,016,849	4,425
1853.....	2,766,194	11.0	663,204	1,975,666	1,141
1852.....	3,130,338	11.0	736,468	2,223,141	1,423
1851.....	2,799,290	9.5	617,468	2,186,461	512
1850.....	2,136,083	12.1	422,626	1,854,474	330
1849.....	1,975,274	12.3	575,506	1,270,763	485
1848.....	2,615,031	7.5	586,032	2,053,204	22
1847.....	2,128,433	8.0	537,427	1,628,549	558
1846.....	1,603,763	11.2	385,916	1,054,440	122
1845.....	1,806,110	7.9	363,365	1,095,116	386
1844.....	2,078,910	5.6	337,730	1,745,812	² 680
1843.....	1,750,060	7.7	298,872	1,327,267	517
1842.....	2,035,481	7.2	278,196	1,584,594	1,835
1841.....	1,398,282	7.8	222,461	1,169,434	107
1840.....	1,347,640	9.5	245,045	1,060,408	1,210
1839.....	1,653,722	8.9	236,525	1,487,882	297
1838.....	1,092,980	13.4	221,738	827,248	319
1837.....	1,428,384	10.1	195,100	1,191,905	355
1836.....	1,129,016	13.2	176,449	888,423	² 510
1835.....	1,061,821	16.5	184,731	847,263	427
1834.....	962,343	17.4	166,523	774,718	1,574
1833.....	930,962	12.9	149,159	769,436	308
1832.....	815,900	12.3	142,352	649,397	69

TABLE X. — *Continued*
 PRODUCTION, CONSUMPTION, EXPORTS AND NET IMPORTS OF RAW COTTON,
 FOR THE UNITED STATES 1790-1923

Year	Cotton production (including linters)		Consumption of cotton and linters (equivalent 500-pound bales) ¹	Exports of domestic cotton (equivalent 500-pound bales)	Net imports (equivalent 500-pound bales)
	Equivalent 500-pound bales, gross weight	Average price per pound Upland cotton (cents)			
1831.....	805,439	9.4	130,895	644,430	² 22
1830.....	732,218	9.7	129,938	553,960	22
1829.....	763,598	10.0	89,723	596,918	378
1828.....	679,916	9.9	84,788	529,674	² 40
1827.....	564,854	10.3	84,516	421,181	597
1826.....	732,218	9.3	103,535	588,620	74
1825.....	533,473	12.2	.....	409,071	79
1824.....	449,791	18.6	.....	352,900	26
1823.....	387,029	14.7	.....	286,739	932
1822.....	439,331	11.4	.....	347,447	110
1821.....	376,569	14.3	.....	289,350	196
1820.....	334,728	14.3	100,000	249,787	427
1819.....	349,372	17.0	.....	255,720	² 4,571
1818.....	261,506	24.0	.....	175,994	² 4,454
1817.....	271,967	34.0	.....	184,942	3,086
1816.....	259,414	26.0	.....	177,299	2,048
1815.....	209,205	29.0	.....	163,894	² 44
1814.....	146,444	21.0	51,778	165,997	² 266
1813.....	156,904	15.5	.....	35,458	101
1812.....	156,904	12.5	.....	38,220	3,133
1811.....	167,364	10.5	.....	57,775	897
1810.....	177,824	15.5	35,565	124,116	431
1809.....	171,548	16.0	33,473	186,523	560
1808.....	156,904	16.0	.....	101,981	² 1,601
1807.....	167,364	19.0	.....	21,261	6,297
1806.....	167,364	21.5	.....	127,889	1,485
1805.....	146,444	22.0	.....	71,315	961
1804.....	135,983	23.0	23,013	76,780	456
1803.....	125,523	20.0	.....	70,068	183
1802.....	115,063	19.0	.....	75,424	² 1,153
1801.....	100,418	19.0	.....	47,768	170
1800.....	73,222	44.0	18,829	31,822	8,696
1799.....	41,841	28.0	16,737	35,580	8,870
1798.....	31,381	44.0	.....	19,065	7,532
1797.....	23,013	39.0	.....	18,720	7,761
1796.....	20,921	34.0	.....	7,577	7,336
1795.....	16,736	36.5	.....	12,213	8,737
1794.....	10,736	36.5	.....	9,414	8,592
1793.....	10,460	33.0	.....	3,565	5,127
1792.....	6,276	32.0	.....	1,097	5,503
1791.....	4,184	29.0	.....	277	1,112
1790.....	3,138	26.0	11,000	379	697

* Average price per pound Upland cotton.

¹ Data collected in running bales. Conversion based on average weights of bales produced, which for the country are heavier than those consumed.

² Excess of exports of foreign cotton over total imports.

§ *Production*. — The production statistics relate, when possible, to the year of growth, but when figures for the growth year are wanting, those for a commercial crop which represent the trade movement have been taken. The statistics of production for the years 1790–1898, inclusive, have been compiled from publications of the Department of Agriculture; for the years 1899–1923, inclusive, and for other years, when available, census figures have been used.

§ *Price of Upland Cotton*. — For the years 1910–1923, inclusive, the price per pound shown for Upland cotton represents the average price received for cotton by the growers as computed by the Department of Agriculture; for the years 1902–1909 it is the average price of the average grade marketed in New Orleans prior to April 1st of the following year; for the years 1890–1901, inclusive,* it is taken from the reports of the Department of Agriculture.

§ *Consumption*. — The statistics of consumption for the year 1790–1894, inclusive, have been compiled from publications of the Department of Agriculture, and those for the years 1895–1903, inclusive, from the reports of Latham Alexander & Co. Census figures have been used for the years 1904–1923, inclusive, and for other years when available. The statistics relate to the twelve months during which the crop of the specified year was chiefly marketed, and not to the calendar year specified.

§ *Domestic Exports and Net Imports*. — For the years 1790–1819, inclusive, the statistics have been taken from American and State papers, and for the years 1820–1923 from the reports on Commerce and Navigation of the United States, published by the Bureau of Foreign and Domestic Commerce, Department of Commerce. For the years 1790–1842, inclusive, the statistics of exports relate to the twelve months beginning with October 1st with the specified year; for 1843–1866, inclusive, to the twelve months beginning with July 1st; for 1867–1913, inclusive, to the twelve months beginning with Sept. 1st; and for 1914–1923 to the twelve months beginning with August 1st. The statistics of imports relate to the same periods as the statistics of exports.

* It is the average price of middling cotton on the New Orleans Cotton Exchange; and for the years 1790–1889, inclusive.

TABLE XI
ESTIMATED QUANTITY OF COTTONSEED PRODUCED, QUANTITY OF COTTONSEED CRUSHED, ESTIMATED QUANTITIES OF CRUDE PRODUCTS OBTAINED, AND EXPORTS OF COTTONSEED PRODUCTS: 1875 TO 1924

Year	Cottonseed		Oil	Cake and meal	Hulls	Linters	Cottonseed exports	
	Produced (tons) ¹	Crushed (tons)	Quantity (gallons)	Quantity (tons)	Quantity (tons)	Quantity (bales of 500 pounds net)	Oil (gallons)	Cake and meal (tons)
1924.....	4,502,000	3,307,598	130,615,609	1,517,859	941,030	642,348	5,255,672	125,183
1923.....	4,336,000	3,241,557	133,722,995	1,487,067	943,773	584,177	8,572,249	227,175
1922.....	3,531,000	3,007,717	124,063,298	1,354,604	936,990	383,547	12,215,285	266,360
1921.....	5,971,000	4,069,166	174,558,000	1,786,000	1,256,000	422,226	37,769,070	227,350
1920.....	5,074,000	4,012,704	161,529,000	1,817,000	1,143,000	584,146	21,253,269	224,786
1919.....	5,360,000	4,478,508	176,711,000	2,170,000	1,137,000	889,500	23,827,978	155,813
1918.....	5,040,000	4,251,680	174,996,000	2,068,000	996,000	1,080,802	13,437,331	22,340
1917.....	5,113,000	4,479,176	187,688,000	2,225,000	969,000	1,273,345	21,198,086	575,080
1916.....	4,992,000	4,202,313	167,110,000	1,923,000	1,220,000	889,577	35,534,941	528,611
1915.....	7,186,000	5,779,665	229,260,000	2,648,000	1,677,000	820,274	42,448,870	739,533
1914.....	6,305,000	4,847,628	193,330,000	2,220,000	1,400,000	660,087	25,728,411	399,987
1913.....	6,104,000	4,579,508	185,750,000	1,999,000	1,540,000	583,091	42,031,052	564,046
1912.....	6,997,000	4,921,073	201,650,000	2,151,000	1,642,000	533,099	53,262,796	646,845
1911.....	5,175,000	4,106,000	167,970,000	1,792,000	1,375,000	379,576	30,069,459	402,298
1910.....	4,462,000	3,269,000	131,000,000	1,326,000	1,189,000	296,640	29,860,667	320,044
1909 ²	5,904,000	3,670,000	146,790,000	1,492,000	1,330,000	330,277	51,087,329	875,164
1908.....	4,952,000	2,565,000	103,050,000	1,043,000	927,000	256,487	41,019,991	466,446
1907.....	5,913,000	3,844,000	153,760,000	1,563,000	1,393,000	307,518	41,880,304	670,484
1906.....	5,060,000	3,131,000	125,700,000	1,272,000	1,135,000	219,397	43,793,519	555,417
1905.....	6,427,000	3,345,000	133,820,000	1,360,000	1,213,000	235,586	51,535,580	625,954
1904.....	4,716,000	3,241,000	121,880,000	1,156,000	1,528,000	194,486	29,013,743	410,175
1903.....	5,092,000	3,269,000	122,910,000	1,165,000	1,541,000	150,366	35,642,994	550,196
1902.....	4,630,000	3,154,000	118,610,000	1,125,000	1,487,000	145,103	33,042,848	525,233
1901.....	4,830,000	2,415,000	96,610,000	845,000	1,139,000	111,096	49,356,741	629,344
1900.....	4,668,000	2,479,000	93,330,000	884,000	1,169,000	114,544	46,902,390	571,852
1899.....	5,472,000	2,353,000	94,110,000	823,000	.....	.....	50,627,219	539,997
1898.....	5,253,000	2,101,000	84,040,000	735,000	.....	.....	40,230,784	459,864

TABLE XI. — Continued

ESTIMATED QUANTITY OF COTTONSEED PRODUCED, QUANTITY OF COTTONSEED CRUSHED, ESTIMATED QUANTITIES OF CRUDE PRODUCTS OBTAINED, AND EXPORTS OF COTTONSEED PRODUCTS: 1875 TO 1924

Year	Cottonseed		Oil	Cake and meal	Hulls	Linters	Cottonseed exports	
	Produced (tons) ¹	Crushed (tons)					Oil (gallons)	Cake and meal (tons)
1897.....	4,070,000	1,628,000	65,120,000	570,000	.....	.....	27,198,882	311,693
1896.....	3,416,000	1,435,000	57,390,000	502,000	.....	.....	19,445,848	202,469
1895.....	4,792,000	1,677,000	67,090,000	587,000	.....	.....	21,187,728	244,858
1894.....	3,579,000	1,431,000	57,260,000	501,000	.....	.....	14,958,309	.....
1893.....	3,183,000	1,050,000	42,010,000	368,000	.....	.....	9,462,074	.....
1892.....	4,274,000	1,068,000	42,740,000	374,000	.....	.....	13,859,278	.....
1891.....	4,093,000	1,023,000	40,930,000	358,000	.....	.....	11,003,160	.....
1890.....	3,495,000	874,000	34,950,000	306,000	.....	.....	13,384,385	.....
1889.....	3,310,000	794,000	31,770,000	278,000	.....	.....	2,690,700	.....
1888.....	3,291,000	823,000	32,910,000	288,000	.....	.....	4,458,597	.....
1887.....	3,018,000	694,000	27,770,000	243,000	.....	.....	4,067,138	.....
1886.....	3,045,000	578,000	23,140,000	202,000	.....	.....	6,240,139	.....
1885.....	2,625,000	499,000	19,950,000	174,000	.....	.....	6,364,279	.....
1884.....	2,639,000	396,000	15,840,000	138,000	.....	.....	3,605,946	.....
1883.....	3,266,000	392,000	15,680,000	137,000	.....	.....	415,611	.....
1882.....	2,455,000	295,000	11,780,000	103,000	.....	.....	713,549	.....
1881.....	3,039,000	182,000	7,290,000	64,000	.....	.....	3,444,084	.....
1880.....	2,616,000	235,000	9,420,000	82,000	.....	.....	6,997,796	.....
1879.....	2,268,000	181,000	7,260,000	64,000	.....	.....	5,352,530	.....
1878.....	2,148,000	150,000	6,020,000	53,000	.....	.....	4,992,349	.....
1877.....	1,969,000	98,000	3,940,000	34,000	.....	.....	1,705,422	.....
1876.....	2,057,000	123,000	4,940,000	43,000	.....	.....	281,054	.....
1875.....	1,687,000	84,000	3,370,000	30,000	.....	.....	417,387	.....

¹ Relates to crop of preceding year.

² The figures of the Thirteenth Census are not shown in this table because they do not represent a single growth-year. (In the preparation of this table a number of sources of information have been utilized, but it has been found impracticable to secure in all instances satisfactory data for the years indicated, and only an approximation to the facts is claimed. Statistics of the quantity of seed produced relate to the preceding crop year and the quantity of crushed and of cottonseed products to the year ending July 31st, while the statistics of exports are for the year ending June 30th.)

TABLE XII

PERCENTAGE REDUCTION FROM FULL YIELD PER ACRE OF COTTON FROM STATED CAUSES, AS REPORTED BY CROP CORRESPONDENTS, 1909-1923

Year	Defi- cient moisture	Exces- sive moisture	Other climatic	Total climatic	Plant diseases	Insect pests	Other or un- known	Total
PER CENT								
1923.....	7.2	8.0	2.8	18.0	0.7	26.6	0.2	45.5
1922.....	10.3	4.9	2.3	17.5	0.8	26.7	0.2	45.2
1921.....	8.6	4.3	3.1	16.0	1.0	35.4	0.5	52.9
1920.....	2.2	8.8	2.1	13.1	1.1	24.0	0.8	39.0
1919.....	2.7	15.3	3.2	21.2	1.4	18.8	0.5	41.9
1918.....	23.8	0.9	4.5	29.2	2.0	7.9	1.2	40.3
1917.....	15.1	1.7	8.7	25.5	1.3	12.3	0.8	39.9
1916.....	9.2	9.1	6.9	25.2	0.9	15.7	0.6	42.4
1915.....	6.8	5.7	6.8	19.3	1.9	12.2	3.4	36.8
1914.....	7.9	2.9	3.0	13.8	0.2	9.8	1.6	25.4
1913.....	15.2	2.0	5.9	23.1	0.5	8.9	1.2	33.7
1912.....	8.1	7.6	5.0	20.7	4.3	6.5	1.2	32.7
1911.....	9.8	2.6	3.0	15.4	0.4	7.9	2.4	26.1
1910.....	12.2	5.1	5.3	22.6	0.4	7.5	5.1	35.6
1909.....	14.9	6.0	7.7	28.6	4.2	7.9	1.3	42.0

TABLE XIII

WORLD'S COTTON SPINDLES (ACTIVE AND IDLE) 1924

Country	Cotton spindles (number)	Country	Cotton spindles (number)
Total.....	159,109,000	Europe, <i>continued</i> :	
United States.....	37,804,000	Netherlands.....	686,000
Europe:		Sweden.....	568,000
United Kingdom.....	56,750,000	Esthonia.....	576,000
France.....	9,359,000	Portugal.....	503,000
Germany.....	9,464,000	Finland.....	251,000
Russia.....	7,246,000	Other Europe.....	604,000
Italy.....	4,570,000	India.....	7,928,000
Czechoslovakia.....	3,460,000	Japan.....	4,825,000
Spain.....	1,813,000	China.....	3,300,000
Belgium.....	1,741,000	Brazil.....	1,700,000
Switzerland.....	1,515,000	Canada.....	1,167,000
Poland.....	1,101,000	Mexico.....	802,000
Austria.....	1,051,000	All other countries.....	325,000

TABLE XIV

COUNTIES IN THE UNITED STATES HAVING MORE THAN 100,000 COTTON SPINDLES EACH, ARRANGED IN ORDER OF NUMBER OF SPINDLES: 1924

County	Spindles	County	Spindles
Bristol, Mass.....	7,704,780	Rutherford, N. C.....	204,236
Providence, R. I.....	1,848,544	Rockingham, N. C.....	201,668
Middlesex, Mass.....	1,122,976	Aiken, S. C.....	198,616
Gaston, N. C.....	1,110,260	Laurens, S. C.....	194,656
Spartanburg, S. C.....	941,748	Richmond, Ga.....	190,016
Hillsboro, N. H.....	897,660	Knox, Tenn.....	184,652
Greenville, S. C.....	771,364	Chambers, Ala.....	184,360
Worcester, Mass.....	725,048	Newberry, S. C.....	181,816
Hampden, Mass.....	707,208	Durham, N. C.....	179,798
Windham, Conn.....	698,472	Stanly, N. C.....	179,648
Essex, Mass.....	657,460	Cleveland, N. C.....	179,036
Anderson, S. C.....	595,920	Alamance, N. C.....	176,520
Kent, R. I.....	591,186	Troup, Ga.....	174,646
Berkshire, Mass.....	548,820	Talladega, Ala.....	169,732
New London, Conn.....	489,880	Calhoun, Ala.....	169,438
Pittsylvania, Va.....	467,440	Rowan, N. C.....	168,364
Oneida, N. Y.....	462,208	Kennebec, Me.....	157,768
Muscogee, Ga.....	445,780	Chester, S. C.....	152,120
Androscoggin, Me.....	406,264	Lancaster, S. C.....	151,768
York, Me.....	406,264	Cumberland, Me.....	147,792
Cabarrus, N. C.....	402,426	Halifax, N. C.....	147,080
Union, S. C.....	339,852	Tallapoosa, Ala.....	140,256
Stratford, N. H.....	323,256	Floyd, Ga.....	133,744
Mecklenburg, N. C.....	309,150	Catawba, N. C.....	133,156
Guilford, N. C.....	301,890	Davidson, N. C.....	128,980
Hudson, N. J.....	268,904	Spalding, Ga.....	122,168
York, S. C.....	265,330	Merrimack, N. H.....	112,876
Richland, S. C.....	251,348	Robeson, N. C.....	110,936
Madison, Ala.....	246,544	Lincoln, N. C.....	109,108
Greenwood, S. C.....	230,436	McDowell, N. C.....	108,416
Albany, N. Y.....	229,124	Caldwell, N. C.....	106,552
Bristol, R. I.....	226,164	Vance, N. C.....	104,184
Cherokee, S. C.....	222,108	Newton, Ga.....	104,020
Pickens, S. C.....	217,400	Iredell, N. C.....	103,584
Hampshire, Mass.....	211,080	Hall, Ga.....	101,812
Fulton, Ga.....	206,488	Orleans, La.....	100,748
Richmond, N. C.....	204,960		

TABLE XV

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Acme.....	34.3	6	1 $\frac{3}{8}$	5	83	1	....	...
Acola.....	35.0	2	1 $\frac{1}{8}$	2	....	....	....	...
Adcock Special.....	36.0	1	....	....	59	....	....	...
Affi.....	32.3	2	....	....	129	1	4000	1
African Limbless.....	34.5	2	....	....	88	1	....	...
Allen.....	33.1	16	2 $\frac{2}{3}$	5	84	4	....	...
Allen Big Boll.....	31.9	3	3 $\frac{3}{4}$	1	59	3	3500	1
Allen Hybrid.....	29.8	3	....	....	89	1	....	...
Allen Long Staple.....	29.6	58	1 $\frac{5}{16}$	32	81	18	4007	9
Allen X King.....	33.3	1	....	....	67	1	....	...
Allen Peerless.....	35.0	1	....	....	64	1	....	...
Alvacado.....	35.5	1	....	....	....	....	....	...
Anderson Prolific.....	30.5	1	....	....	64	1	3600	1
Ansley Improved.....	34.0	1	....	....	61	1	....	...
Ansons Cream.....	31.6	1	....	....	88	1	....	...
Ashcroft.....	31.5	11	1 $\frac{1}{4}$	10	....	....	....	...
Baily.....	33.3	5	1 $\frac{1}{8}$	2	72	2	....	...
Baker Improved.....	30.0	1	....	....	62	1	....	...
Banaza.....	37.8	1	....	....	78	1	....	...
Bancroft Long Sta.....	28.6	1	....	....	....	....	....	...
Bank Account.....	34.5	26	7 $\frac{7}{8}$	21	79	20	4228	13
Banks Big Boll.....	31.6	1	....	....	50	1	....	...
Barber Improved.....	33.5	3	....	....	68	3	....	...
Barnett.....	33.7	5	1	1	73	2	....	...
Bates Big Boll.....	30.0	2	....	....	....	....	....	...
Bates.....	38.0	1	....	....	....	....	....	...
Bates Early.....	34.6	1	....	....	91	1	....	...
Bates Favorite.....	35.1	2	....	....	72	1	3703	1
Bates Improved.....	35.1	2	....	....	80	1	4762	...
Bates Prolific.....	37.5	1	....	....	84	1	....	...
Beck Big Boll.....	30.0	1	....	....	....	....	....	...
Bennett 1 $\frac{1}{8}$	35.2	4	1 $\frac{3}{8}$	5	52	5	3299	4
Bennett.....	37.6	2	3 $\frac{1}{2}$	3	59	3	3606	2
Bennett 1 $\frac{1}{4}$	32.0	3	1 $\frac{5}{32}$	3	80	3	3532	3
Ben Smith.....	34.1	1	....	....	....	....	....	...
Ben Smith Choice.....	30.7	4	....	....	....	....	....	...
Berk Prolific.....	29.0	1	....	....	....	....	....	...

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Berry Big Boll.....	29.1	2	$1\frac{1}{16}$	1	68	1	....	...
Berry Hill Improved.....	33.6	3	$\frac{7}{16}$	2	75	3	....	...
Biamia.....	26.2	1	....	....	111	1	3921	1
Big Boll Selected.....	33.0	1	....	....	60	1	....	...
Bigham.....	34.6	5	$\frac{2\frac{9}{32}}$	6	83	6	4343	5
Big Boll White Seed.....	34.0	1	....	....	50	1	....	...
Bird.....	32.0	1	1	1	83	1	....	...
Black Rattler.....	27.0	2	$1\frac{3}{16}$	2	....	....	....	...
Black Seeded Blue Rib.....	30.0	1	....	....	75	1	....	...
Blackshire Wilt Resistance.....	....	....	$\frac{3}{4}$	1	85	1	....	...
Blue Ribbon.....	31.3	6	$\frac{2\frac{9}{32}}$	1	79	5	4721	1
Boheim.....	31.5	2	....	....	....	....	....	...
Bolivar County.....	33.3	2	....	....	....	....	....	...
Bonair.....	33.3	1	....	....	65	1	....	...
Bowden.....	33.3	1	....	....	54	1	....	...
Bowden Big Boll.....	35.2	1	....	....	46	1	....	...
Boyd Prolific.....	30.4	7	....	....	....	....	....	...
Boykin.....	37.9	5	$\frac{15}{16}$	5	58	5	3489	5
Bradbury.....	38.2	5	$\frac{7}{8}$	1	76	1	....	...
Bradley.....	38.0	1	$\frac{7}{8}$	1	....	....	....	...
Brandon.....	36.2	13	$\frac{15}{16}$	11	64	1	4240	1
Brannon.....	33.0	2	....	....	....	....	....	...
Broadwell.....	34.6	18	$\frac{7}{8}$	12	83	10	4062	8
Broddy.....	39.6	3	....	....	....	....	....	...
Brooks Improved.....	33.2	5	....	....	64	2	....	...
Brown No. 1.....	36.1	15	$\frac{15}{16}$	9	61	6	3416	5
Brown Spring Grove.....	31.0	1	....	....	....	....	....	...
Brun B-1.....	34.0	2	....	....	....	....	....	...
Buck Long Staple.....	33.7	2	....	....	....	....	....	...
Cachrons.....	31.6	2	....	....	....	....	....	...
Caldwell Big Boll.....	33.0	1	....	....	....	....	....	...
Calhoun.....	33.0	6	$1\frac{1}{16}$	4	....	....	....	...
Cameron.....	32.5	4	$\frac{15}{16}$	2	82	1	....	...
Caltharps Pride.....	31.8	2	....	....	....	....	....	...
Cameron Improved.....	34.7	5	....	....	73	5	....	...
Candell Improved.....	32.0	1	....	....	56	1	3500	1
Carolina Gem.....	33.3	4	$1\frac{1}{4}$	4	64	1	....	...

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Carolina Pride.....	32.1	1	....	....	....	....	....	....
Cataba.....	31.1	1	....	....	....	....	....	....
Champion Cluster.....	36.0	1	....	....	....	....	....	....
Cherry Cluster.....	31.2	9	$\frac{7}{8}$	2	....	....	....	....
Cherry Long Staple.....	29.8	6	....	....	....	....	....	....
Christopher.....	33.5	30	$\frac{31}{32}$	22	61	19	3263	13
Cleveland.....	36.3	159	$\frac{31}{32}$	123	63	89	3590	50
Cleveland X Cook.....	37.0	2	$\frac{7}{8}$	1	....	....	....	....
Climax.....	34.0	1	....	....	....	....	....	....
Cochron Extra Prolific.....	31.5	6	....	....	....	....	....	....
Columbia.....	31.6	75	$1\frac{5}{32}$	64	65	41	3306	34
Common.....	28.0	1	....	....	....	....	....	....
Cook.....	37.0	159	$\frac{29}{32}$	98	66	74	3791	53
Cook Long Staple.....	29.8	4	$1\frac{1}{2}$	1	....	....	....	....
Coppedge Improved.....	31.9	1	....	....	65	1	....	....
Corley.....	34.1	3	....	....	56	3	....	....
Corput.....	32.0	1	....	....	64	1	3750	1
Council-Toole.....	35.5	16	1	7	81	5	4168	6
Covington-Toole.....	37.1	46	$\frac{15}{16}$	28	83	15	4369	12
Crawford Big Boll.....	35.2	18	$\frac{15}{16}$	7	59	3	....	....
Crawford Peerless.....	31.0	2	....	....	....	....	....	....
Crossland.....	37.1	2	$\frac{7}{8}$	1	....	....	....	....
Culpepper.....	33.8	32	$\frac{15}{16}$	21	62	21	3570	13
Cunningham.....	34.2	2	$\frac{29}{32}$	2	97	1	3491	1
Dalrymple.....	34.7	3	$1\frac{1}{8}$	3	....	....	....	....
Davis Best.....	33.9	1	....	....	71	1	....	....
Davis Long Staple.....	28.2	3	$1\frac{1}{8}$	3	....	....	....	....
Day.....	32.0	2	$1\frac{1}{16}$	2	....	....	....	....
Dean Special.....	....	....	....	....	80	1	....	....
Deering.....	33.8	11	....	....	90	1	4695	1
Deleaney.....	34.0	1	....	....	68	1	....	....
Desoto.....	34.5	27	1	7	74	5	....	....
Dixon.....	30.1	30	$\frac{7}{8}$	3	92	4	....	....
Dixon X Allen.....	30.0	1	....	....	65	1	....	....
Dixon X Clark.....	31.2	1	....	....	65	1	....	....
Dillon.....	34.3	28	$1\frac{1}{32}$	17	80	17	3928	16
Dillion-Register.....	33.5	2	....	....	....	....	....	....

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Dix-Afifi.....	31.5	22	$1\frac{7}{32}$	5	76	4	....	...
Dixie.....	33.7	57	$\frac{7}{8}$	43	79	27	4304	26
Dixie Improved.....	35.1	34	1	10	79	8	4084	9
Dodd Favorite.....	31.4	30	$1\frac{1}{16}$	30	77	26	3915	24
Dodd Long Staple.....	28.0	1	$1\frac{3}{16}$	1	....	....	....	....
Dodd Prolific.....	31.7	38	$1\frac{1}{32}$	37	83	17	3930	16
Dongola.....	34.5	9	$\frac{7}{8}$	1	67	5	3200	1
Double Jointed.....	34.4	13	$\frac{7}{8}$	15	82	15	4223	11
Double Header.....	33.2	9	$\frac{31}{32}$	5	65	6	3139	4
Doghty Long Staple.....	26.3	3	$1\frac{1}{8}$	1	....	....	....	...
Doghty Improved.....	30.7	2	....	....	66	1	....	...
Dozier Improved.....	35.9	4	$\frac{7}{8}$	1	....	....	....	...
Double Limbed.....	34.0	1	....	....	....	....	....	....
Drake Cluster.....	33.1	19	$\frac{29}{32}$	11	84	11	4869	7
Duncan.....	31.9	2	....	....	....	....	....	....
Duncan Mammoth.....	32.2	5	....	....	62	3	3556	2
Dunlap Storm Proof.....	36.0	2	....	....	80	2	....	....
Durango.....	32.0	36	$1\frac{5}{32}$	39	72	25	3357	23
Durham Improved.....	30.0	2	....	....	67	2	....	....
East Improved Georgia.....	32.9	2	....	....	....	....	....	....
Easy Money.....	38.0	1	....	....	64	1	....	....
Edgemont.....	34.0	1	....	....	....	....	....	....
Edgeworth.....	33.6	3	$\frac{15}{16}$	2	64	1	....	....
Egyptian.....	30.0	1	....	....	80	1	....	....
Ellerrbee Prolific.....	32.9	3	....	....	79	3	4566	3
Ellis Big Boll.....	31.6	1	....	....	57	1	....	....
Ellsworth.....	31.5	7	....	....	....	....	....	....
Endmonson Improved.....	34.3	2	....	....	78	2	....	....
English Ounce Boll.....	33.0	1	....	....	....	....	....	....
Espy Improved.....	35.0	1	....	....	68	1	....	....
Eureka.....	30.7	16	$1\frac{3}{32}$	1	73	1	....	....
Evans.....	38.0	1	....	....	64	1	....	....
Excelsior.....	33.7	22	$\frac{29}{32}$	7	82	10	3856	3
Express.....	29.3	73	$1\frac{5}{32}$	62	77	46	3856	45
Extra Big Boll.....	38.0	1	....	....	....	....	....	....
Extra Early Carolina.....	30.7	3	....	....	....	....	....	....
Extra Early Selection.....	35.0	1	....	....	78	1	....	....

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Featherstone.....	34.0	1	.....	.....	58	1	3800	1
Fennell Prolific.....	29.9	1	.....	.....	.....	.....	.....	...
Fishburn.....	31.6	4	.....	.....	.....	.....	.....	...
Floradora.....	28.9	33	$1\frac{5}{32}$	28	87	33	4057	25
Foster.....	30.4	46	$1\frac{7}{32}$	44	66	30	3520	28
Fowler B. B.....	35.1	1	.....	.....	58	1	.....	...
Franklin Improved.....	36.5	2	.....	.....	109	2	.....	...
Franklin Prolific.....	37.1	4	.....	.....	77	4	.....	...
Garrard.....	37.0	1	.....	.....	.....	.....	.....	...
Gayoso Prolific.....	33.2	2	1	2	.....	.....	.....	...
Gayson Early Prolific.....	32.9	3	.....	.....	.....	.....	.....	...
Georgia Best.....	34.9	18	$\frac{29}{32}$	16	71	19	4037	11
Georgia Prolific.....	33.8	2	.....	.....	.....	.....	.....	...
Georgia Standard.....	31.5	1	.....	.....	93	1	.....	...
Gilberts Long Wool.....	28.5	1	.....	.....	72	1	.....	...
Gold Coin.....	36.0	4	$\frac{15}{16}$	2	84	4	.....	...
Gold Dust.....	30.7	3	$\frac{13}{16}$	2	.....	.....	.....	...
Golden Long Staple.....	26.2	1	.....	.....	98	1	.....	...
Golden Standard.....	40.7	3	.....	.....	75	3	.....	...
Greer Improved.....	36.7	4	.....	.....	95	4	5000	2
Griffin Drouth Proof.....	30.8	3	.....	.....	93	1	.....	...
Griffin Long Staple.....	30.0	6	$1\frac{1}{4}$	3	62	2	.....	...
Gum.....	31.2	1	.....	.....	.....	.....	.....	...
Haaga.....	26.7	1	$1\frac{3}{8}$	1	53	1	3254	1
Haaga Long Staple.....	31.8	3	.....	.....	66	2	.....	...
Haaga No. 1.....	31.4	4	$1\frac{1}{4}$	3	55	1	.....	...
Haaga No. 2.....	28.3	4	$1\frac{17}{32}$	3	66	2	3115	1
Hagaman.....	30.7	5	.....	.....	69	2	.....	...
Hagan Big Boll.....	34.0	1	.....	.....	62	1	.....	...
Half & Half.....	39.7	59	$\frac{29}{32}$	40	75	31	4456	25
Hamilton Ounce-Boll.....	33.7	3	.....	.....	.....	.....	.....	...
Hancock.....	69.0	2	$\frac{14}{16}$	2	.....	.....	.....	...
Harden Improved.....	31.6	1	.....	.....	125	1	.....	...
Harden Prolific.....	34.3	4	1	1	97	3	.....	...
Harley Early Big Boll.....	38.0	2	.....	.....	61	2	.....	...
Harley Improved.....	34.0	1	.....	.....	.....	.....	.....	...
Hart Improved.....	36.0	2	.....	.....	50	2	.....	...

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Hartsville.....	31.8	23	$1\frac{3}{16}$	15	60	9	2913	6
Hawkins.....	33.7	57	$\frac{15}{16}$	22	79	13	4775	5
Hawkins Jumbo.....	33.6	5	$\frac{7}{8}$	1	75	3	4000	1
Hendrie Big Boll.....	36.0	2	....	....	51	2	....	....
Herlong.....	29.2	31	$\frac{15}{16}$	4	71	4	3725	4
Herndon Select.....	32.1	1	....	....	76	1	....	....
Hillard.....	33.4	1	....	....	....	....	....	....
Hip Improved.....	37.8	4	....	....	67	4	....	....
Hite.....	36.5	24	$\frac{15}{16}$	12	95	6	....	....
Holden Big Boll.....	....	....	$\frac{14}{16}$	2	54	2	....	....
Hooper Big Boll.....	30.0	1	....	....	....	....	....	....
Howell.....	34.2	1	....	....	....	....	....	....
Hunnicutt.....	31.1	12	$\frac{15}{16}$	2	73	4	3839	2
Hutchinson Prolific.....	33.2	1	....	....	54	1	....	....
Hutchinson Storm Proof...	28.6	3	....	....	64	2	3850	1
Huey Big Boll.....	26.7	1	....	....	73	1	....	....
Ideal Big Boll.....	34.8	5	....	....	....	....	....	....
Improved Prolific.....	33.3	1	....	....	....	....	....	....
Jackson Limbless.....	36.6	4	1	1	88	1	....	....
Japan.....	28.0	1	....	....	....	....	....	....
Jenkins Gold Dust.....	31.4	1	....	....	82	1	....	....
Jeter.....	35.0	1	$\frac{3}{4}$	1	....	....	....	....
John Bull Long Staple.....	29.3	1	$1\frac{1}{2}$	1	....	....	....	....
Johnes Prolific.....	31.4	3	....	....	....	....	....	....
Johnstons Ideal.....	36.8	1	....	....	82	1	....	....
Jones Improved.....	33.4	27	$\frac{7}{8}$	6	61	13	3186	5
Jones Long Staple.....	29.1	10	$1\frac{3}{16}$	3	77	1	....	....
Jones No. 1.....	31.7	1	$\frac{13}{16}$	1	....	....	....	....
Jones Prolific Big Boll.....	33.5	1	....	....	50	1	....	....
Jones Rain Proof.....	33.6	2	$\frac{15}{16}$	2	64	2	3325	1
Jones Wonderful.....	29.6	4	....	....	70	3	3536	2
Jowers Improved.....	31.6	8	....	....	....	....	....	....
Keenan.....	32.1	32	$1\frac{5}{32}$	27	67	12	3049	10
Keith.....	32.6	4	1	2	84	1	....	....
Kelley.....	35.2	1	....	....	....	....	....	....
Kentucky Bender.....	31.0	2	$1\frac{1}{16}$	2	....	....	....	....
Kimbrough.....	....	....	$\frac{15}{16}$	1	54	1	....	....

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
King.....	35.2	149	$\frac{28}{32}$	101	86	102	4375	70
King X Triumph.....	32.7	4	$\frac{31}{32}$	4	63	4	3476	4
Kimbrough Improved.....	.....	.....	$\frac{15}{16}$	1	54	1	.....	.....
Knight Small Seed.....	32.2	1	.....	.....	89	1	5000	1
Langford Big Boll.....	36.2	12	$\frac{15}{16}$	4	53	5	4200	1
Latimer Pride.....	30.0	1	$1\frac{3}{8}$	1	.....	.....	.....	.....
Layton.....	37.5	17	$1\frac{3}{16}$	7	87	15	4839	5
Leary Early Bird.....	32.5	1	.....	.....	71	1	.....	.....
Lee.....	35.0	11	1	1	66	2	4550	2
Leland.....	31.3	3	.....	.....	89	2	.....	.....
Lewis Long Staple.....	31.9	8	$1\frac{1}{4}$	7	74	1	.....	.....
Lewis Prize.....	36.8	8	$\frac{15}{16}$	3	82	5	5225	2
Lewis Prolific.....	34.5	2	1	1	76	1	4000	1
Lewis 63.....	35.6	32	$\frac{31}{32}$	9	86	7	4320	8
Little Brannon.....	33.0	4	.....	.....	.....	.....	.....	.....
Little Improved.....	34.5	2	.....	.....	64	2	.....	.....
Lone Star.....	35.3	67	$1\frac{1}{16}$	63	56	49	3267	43
Lowe Improved.....	33.5	1	$1\frac{1}{16}$	1	47	1	3000	1
Lowyre Prolific.....	33.0	2	.....	.....	82	1	.....	.....
McBride B. B.....	34.0	2	.....	.....	.....	.....	.....	.....
McGhee Southern Hope.....	32.6	2	.....	.....	.....	.....	.....	.....
McCall.....	31.9	2	.....	.....	74	1	4400	1
McKay July.....	35.1	1	$\frac{3}{4}$	1	66	1	4420	1
Maddox Improved.....	32.5	1	.....	.....	59	1	.....	.....
Mcgruder Marvel.....	31.4	2	.....	.....	.....	.....	.....	.....
Mammoth Cluster.....	28.0	1	.....	.....	.....	.....	.....	.....
Mammoth Prolific.....	32.6	6	$1\frac{1}{8}$	1	58	1	.....	.....
Many Mack Special.....	33.0	2	$\frac{3}{4}$	2	.....	.....	.....	.....
Marston.....	23.8	3	.....	.....	.....	.....	.....	.....
Mary Bick.....	33.3	1	.....	.....	67	1	.....	.....
Mascott.....	35.7	5	.....	.....	83	3	5650	1
Mathless Extra Early.....	.....	.....	$\frac{27}{32}$	2	67	2	.....	.....
Matthews Long Staple.....	30.6	6	$1\frac{1}{8}$	1	.....	.....	.....	.....
Maxly.....	31.9	3	.....	.....	.....	.....	.....	.....
Meadow Early Cluster.....	.....	.....	$\frac{27}{32}$	2	63	2	.....	.....
Metcalf.....	31.0	2	$1\frac{1}{8}$	2	.....	.....	.....	.....
Meridith.....	33.3	4	.....	.....	52	3	3050	1

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Mexican Big Boll.....	32.9	12	$\frac{29}{32}$	3	55	4	....	....
Mikado.....	32.1	2	....	....	90	1	....	....
Miller.....	35.7	7	$\frac{11}{16}$	7	....	....	....	....
Mills Select Egyptian.....	28.2	1	....	....	67	1	....	....
Minar.....	30.9	2	....	....	78	2	....	....
Minter.....	31.4	2	....	....	84	1	....	....
Mississippi Long Staple....	29.8	1	$1\frac{1}{8}$	2	73	2	3279	1
Mississippi Silk.....	24.0	2	$1\frac{7}{16}$	2	....	....	....	....
Mitchell Early Prolific.....	39.3	5	$\frac{13}{16}$	2	....	....	....	....
Mitchell Twin Boll.....	33.8	1	....	....	88	1	....	....
Mixed.....	33.1	13	$\frac{31}{32}$	12	75	13	3624	12
Mixon.....	28.0	1	....	....	....	....	....	....
Modella.....	35.9	25	$\frac{31}{32}$	10	78	9	3980	9
Money Maker.....	38.1	12	1	8	86	1	....	....
Moore Improved.....	35.3	2	....	....	73	2	4500	1
Mooreland Improved.....	33.3	1	....	....	62	1	....	....
Morgan Climax.....	36.0	1	....	....	69	1	....	....
Morris.....	33.2	4	....	....	....	....	....	....
Mortgage Lifter.....	33.5	20	$\frac{15}{16}$	14	63	14	3422	10
Morton Prolific.....	31.5	3	....	....	88	1	....	....
Moss Improved.....	40.7	17	$\frac{29}{32}$	4	76	10	5290	4
Multiplier.....	33.0	2	$\frac{3}{4}$	2	....	....	....	....
Musk Green Leaf.....	37.0	2	....	....	80	2	....	....
Nancy Cane.....	30.8	5	$1\frac{1}{8}$	5	....	....	....	....
Nancy Hanks.....	34.2	6	....	....	69	5	3850	1
Nealey Improved.....	33.5	2	1	1	69	2	3580	1
Neill Extra Big Boll.....	31.0	1	....	....	....	....	....	....
Nelisslar Improved.....	32.0	1	....	....	....	....	....	....
Nelsonian.....	....	....	$\frac{3}{4}$	1	111	1	5040	1
New Century.....	30.0	1	$1\frac{1}{8}$	1	....	....	....	....
Ninety Day.....	34.3	4	$\frac{27}{32}$	3	....	....	....	....
No Chop.....	35.1	4	$\frac{15}{16}$	4	70	4	4027	4
Norfolk Champion.....	34.6	1	....	....	82	1	....	....
Norris.....	32.0	2	....	....	60	2	....	....
Norwood.....	....	....	$\frac{29}{32}$	1	96	1	4582	1
No. 177.....	36.7	2	$\frac{27}{32}$	2	65	2	3749	1
Oats.....	33.6	4	....	....	....	....	....	....

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Okra Leaf.....	32.6	21	1 $\frac{1}{8}$	2	98	1	....	...
One Thousand and One...	33.4	4	....	....	....	....	....	...
Ozier.....	33.3	5	....	....	....	....	....	...
Ozier Silk.....	28.0	1	....	....	....	....	....	...
P. & B. Silk.....	28.2	9	1 $\frac{9}{32}$	9	77	7	3496	8
Page.....	33.8	6	1 $\frac{3}{32}$	6	63	5	3485	5
Parker.....	34.1	1	....	....	....	....	....	...
Payne Big Boll.....	30.7	1	....	....	70	1	....	...
Peeler.....	30.9	10	1 $\frac{1}{4}$	2	....	....	....	...
Peerless.....	31.5	26	1 $\frac{1}{16}$	5	90	1	....	...
Pemiscot.....	30.3	12	1 $\frac{5}{32}$	12	64	12	3187	11
Perfection.....	36.0	3	....	....	....	....	....	...
Perry.....	37.0	14	1 $\frac{3}{16}$	5	....	....	....	...
Peterkin.....	35.7	69	$\frac{15}{16}$	17	82	22	4978	12
Petit Gulf.....	30.0	12	$\frac{15}{16}$	2	....	....	....	...
Petway.....	33.3	5	$\frac{29}{32}$	3	4	4	4490	2
Piedmont Long Staple.....	32.8	5	1 $\frac{1}{4}$	4	124	1	....	...
Pineapple.....	35.3	1	....	....	72	1	....	...
Pinkerton.....	35.0	1	....	....	71	1	....	...
Pirtle.....	33.4	1	$\frac{29}{32}$	1	67	1	3524	1
Pittman.....	33.5	2	....	....	....	....	....	...
Phillips Improved.....	37.0	1	....	....	125	1	....	...
Polk.....	30.2	10	1 $\frac{5}{32}$	10	75	8	3665	8
Poor Man's Relief.....	34.2	2	....	....	....	....	....	...
Poulnot.....	35.6	36	1	10	67	22	3604	10
Pride of Georgia.....	33.0	6	1 $\frac{1}{8}$	2	70	3	....	...
Prize.....	37.4	8	$\frac{15}{16}$	4	69	3	5100	1
Ramses.....	29.7	5	$\frac{7}{8}$	1	....	....	....	...
Ray Improved.....	30.0	1	....	....	....	....	....	...
Ray Prolific.....	36.0	1	$\frac{7}{8}$	1	....	....	....	...
Reeding.....	33.8	2	....	....	55	2	....	...
Rehinsens Big Boll.....	28.0	1	....	....	78	1	....	...
Reliable.....	34.3	3	....	....	56	3	3225	2
Richmond Bender.....	31.0	2	1 $\frac{1}{16}$	2	....	....	....	...
Richmond Long Staple.....	29.0	2	1 $\frac{3}{16}$	....	....	....	....	...
Richmonds Pride.....	40.3	2	....	....	103	2	5300	1
Ricks Improved.....	36.4	4	$\frac{27}{32}$	4	....	....	....	...

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Robbies Prolific.....	34.0	1	....	....	....	....	....	....
Roberts & Tucker.....	34.8	3	$\frac{15}{16}$	4	64	4	3492	3
Roberts Early Big Boll.....	31.0	1	....	....	....	....	....	....
Roby.....	34.0	1	....	....	82	1	5000	1
Rodgers.....	34.9	6	....	....	89	1	....	....
Rocket Favorite.....	33.2	2	....	....	....	....	....	....
Rocket Improved.....	31.6	1	....	....	....	....	....	....
Rosser No. 1.....	34.0	15	$\frac{7}{8}$	12	69	13	4020	8
Round Nose.....	34.7	17	1	17	58	17	3334	15
Royal Art Silk.....	31.4	1	....	....	66	1	3448	1
Rowden.....	34.1	74	$1\frac{1}{16}$	67	57	53	3055	47
Rublee.....	34.4	45	$\frac{31}{32}$	45	70	37	3768	28
Ruby Prolific.....	34.6	2	....	....	92	2	....	....
Rucker Select.....	....	....	$1\frac{2}{16}$	2	67	2	....	....
Russell Big Boll.....	33.1	40	1	20	63	20	3355	9
Sam Woodfin Prolific.....	35.3	5	....	....	....	....	....	....
Sawyer.....	36.9	7	$\frac{31}{32}$	4	62	5	3313	4
Scharbrough.....	24.0	1	$1\frac{3}{8}$	1	....	....	....	....
Schley.....	34.7	22	$\frac{15}{16}$	9	64	19	3670	8
Scrub.....	28.6	1	$\frac{7}{8}$	1	....	....	....	....
Sea Island.....	26.5	16	$1\frac{3}{8}$	7	133	8	3704	7
Shanks High.....	35.8	2	....	....	83	2	....	....
Shine.....	33.1	34	$\frac{15}{16}$	20	85	17	4287	10
Simmons Improved.....	34.0	1	....	....	....	....	....	....
Simms Long Staple.....	30.0	3	....	....	77	2	4150	1
Simpkins Big Boll.....	34.6	15	$\frac{31}{32}$	15	68	11	3401	10
Simpkins Ideal.....	34.2	50	$\frac{7}{8}$	35	84	18	4072	13
Simpkins Excelsior.....	32.6	1	....	....	....	....	....	....
Simpkins Prolific.....	35.7	20	$\frac{27}{32}$	18	87	17	4236	11
Smith Improved.....	33.1	11	$\frac{31}{32}$	2	63	7	3315	2
South Carolina Pride.....	31.0	1	....	....	....	....	....	....
Southern Hope.....	30.7	16	$1\frac{3}{8}$	5	82	4	3636	1
Southern Wonder.....	31.2	3	....	....	59	1	3600	1
Spears Extra Early.....	....	....	$1\frac{3}{16}$	2	59	2	....	....
Speerman.....	37.0	1	....	....	63	1	3600	22
Spring Grove.....	38.2	4	$\frac{3}{4}$	1	....	....	....	....
Sproull.....	33.3	30	1	30	54	28	3135	25

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Sterling.....	29.3	1	....	....	93	1	....	...
Storm Proof.....	32.0	2	$1\frac{1}{16}$	2	....	....	....	...
Strickland.....	32.5	8	1	1	51	5	2950	1
Stone Improved.....	37.0	1	....	....	64	....	....	...
Stoney.....	36.7	4	....	....	74	1	5155	1
Stroughn.....	35.0	2	$\frac{7}{8}$	2	....	....	....	...
Stucky Improved.....	36.0	1	....	....	....	....	....	...
Sugar Loaf.....	37.2	14	$\frac{13}{16}$	7	85	5	4480	1
Sunbeam.....	35.4	10	$\frac{15}{16}$	7	70	4	3043	2
Sunflower.....	28.6	23	$1\frac{3}{8}$	18	90	3	....	...
Sure Crop.....	32.1	16	$\frac{15}{16}$	17	65	18	3616	14
Sure Fruit.....	34.0	2	....	....	....	....	....	...
Tatum Big Boll.....	33.0	6	$1\frac{1}{16}$	4	57	5	3415	2
Taylor.....	30.1	3	1	1	....	....	....	...
Tennessee Gold Dust.....	32.7	10	....	....	....	....	....	...
Tennessee Golden Proof....	34.0	1	....	....	....	....	....	...
Tennessee Silk.....	31.5	3	....	....	....	....	....	...
Texas Burr.....	34.3	25	$\frac{15}{16}$	12	59	20	3431	10
Texas Oak.....	36.1	6	....	....	77	3	....	...
Texas Storm Proof.....	33.7	14	....	....	....	....	....	...
Texas Wood.....	36.7	8	$\frac{13}{16}$	5	87	4	....	...
Thigpin Prolific.....	36.4	9	$\frac{15}{16}$	5	57	1	....	...
Thornton.....	29.0	1	$1\frac{3}{8}$	1	....	....	....	...
Thresh Select.....	32.4	2	....	....	53	2	....	...
Tommy.....	30.0	1	$1\frac{1}{8}$	1	....	....	....	...
Toole.....	37.5	60	$1\frac{1}{4}$	27	87	30	4865	18
Trice.....	31.7	130	1	129	74	103	3598	92
Tri-Cook.....	35.5	6	$\frac{2}{3}\frac{9}{2}$	6	68	5	3873	6
Triumph.....	57.3	102	1	133	58	110	....	...
Truitt.....	33.1	73	$\frac{15}{16}$	30	67	22	3391	12
Turner Improved.....	31.7	1	....	....	55	1	....	...
Turnipseed.....	37.5	2	....	....	49	2	....	...
Tyler.....	30.1	6	....	....	84	2	3700	1
Uncle Sam.....	36.3	13	$1\frac{1}{32}$	6	57	2	....	...
Unknown.....	33.2	9	$1\frac{3}{32}$	6	73	3	3744	2
Upham Improved.....	37.0	1	....	....	83	1	....	...

TABLE XV. — *Continued*

SUMMARY OF ALL PUBLISHED DATA ON THE IMPORTANT CHARACTERS OF 442
VARIETIES OF COTTON, AS GIVEN IN ARKANSAS STATION BULLETIN 157

Variety	Per cent lint		Length of lint inches		No. of bolls per pound		No. of seed per pound	
	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.	Aver- age	No. of expts.
Upland Long Staple.....	28.0	1	....	....	78	1	....	...
Upright.....	37.0	1	$\frac{25}{32}$	3	67	1	....	...
Utopia.....	36.5	2	....	....	75	1	....	...
Vandiver Heavy Fruiter....	34.3	3	....	....	....	....	....	...
Victor.....	34.7	1	....	....	62	1	....	...
Virgatus.....	35.2	10	$\frac{15}{16}$	9	67	9	3842	7
Wall Prolific.....	34.4	3	....	....	73	3	....	...
Watson Reimproved.....	....	....	$\frac{7}{8}$	2	59	2	....	...
Webber.....	32.2	82	$1\frac{5}{32}$	62	95	48	3398	44
Weekly Long Staple.....	27.0	1	....	....	83	1	....	...
Welborn Pet.....	31.7	17	$\frac{27}{32}$	1	94	2	7688	1
Whaley.....	29.5	4	....	....	....	....	....	...
Whately Improved.....	31.3	2	....	....	....	....	....	...
Whittle.....	34.0	1	....	....	....	....	....	...
Wilber No. 2.....	32.1	18	....	....	93	3	....	...
Willborn.....	30.0	4	1	1	100	1	....	...
Willet.....	36.1	10	$\frac{7}{8}$	1	69	3	3900	1
Willet Red Leaf.....	36.5	2	$\frac{7}{8}$	3	78	3	4620	...
Williamatic.....	35.0	1	....	....	....	....	....	...
Williams.....	33.1	10	$\frac{7}{8}$	1	70	5	....	...
Williamson.....	35.0	1	....	....	....	....	....	...
Willis.....	29.9	1	....	....	....	....	....	...
Willson Matchless.....	34.4	1	....	....	64	1	4450	1
Winesap.....	35.0	6	$\frac{27}{32}$	3	....	....	....	...
Wise.....	36.2	2	....	....	64	1	5100	1
Wonderful.....	28.8	2	$1\frac{3}{8}$	1	....	....	....	...
Woodfin Prolific.....	30.8	5	$1\frac{1}{8}$	1	83	3	4550	1
Wood.....	33.3	10	$\frac{15}{16}$	8	85	8	4375	7
Wood Register.....	33.7	3	....	....	....	....	....	...
World Wonder.....	31.6	11	$1\frac{1}{32}$	12	75	5	4218	2
Wyche Improved.....	35.8	1	....	....	62	1	....	...
Zillnore.....	30.8	6	$\frac{15}{16}$	2	....	....	....	...

TABLE XVI
A LIST OF THE COTTON COÖPERATIVE ASSOCIATIONS AND THE ADDRESS OF
EACH CENTRAL OFFICE

Name of Association	Address
The American Cotton Growers' Exchange...	Memphis, Tennessee
Alabama Farm Bureau Cotton Association..	Montgomery, Alabama
Arizona Cotton Growers' Association.....	Phoenix, Arizona
Arkansas Cotton Growers' Association.....	Little Rock, Arkansas
Georgia Cotton Growers' Coöperative Association.....	Atlanta, Georgia
Louisiana Cotton Growers' Association....	Baton Rouge, Louisiana
Staple Cotton Growers' Association.....	Greenwood, Mississippi
Missouri Cotton Growers' Association.....	New Madrid, Missouri
Mississippi Cotton Growers' Coöperative Association.....	Jackson, Mississippi
North Carolina Cotton Growers' Association.....	Raleigh, North Carolina
Oklahoma Cotton Growers' Association....	Oklahoma City, Oklahoma
South Carolina Cotton Growers' Coöperative Association.....	Columbia, South Carolina
Tennessee Cotton Growers' Coöperative Association.....	Memphis, Tennessee
Texas Bureau Cotton Association.....	Dallas, Texas

INDEX

A

Acreage planted to cotton in specific countries, 223
 Alkali, resistance of cotton to, 208
 American cotton, 26
 American-Egyptian cotton, alkali, resistance to, 208
 cultural practices followed with, 208
 early breeding work with, 206
 enemies of, 209
 grades of, 212
 land renovating value of, 211
 localities of the United States adapted to, 206
 maintaining a supply of pure seed of, 207
 origin of, 206
 picking of, 209
 planting of, 207
 preparation of soil for, 207
 production of, 206, 212, 222
 ratooning, 209
 lint, use of, 212
 American Upland, long staple, where grown, 27
 species, origin of, 26
 description of, 26
 Ammonium nitrate, value as a fertilizer, 87, 96
 Ammonium sulphate, source of, 84
 value of, 94, 95, 96
 Arizona wild cotton, 209
 Asiatic cotton, 26

B

Bales, description of, 152
 density of, 153, 160
 plated, 154
 round, 152
 Sea Island, 153
 size of, 160

Bales, size of, American-Egyptian, 152
 upland, 152
 standard flat, 152
 Beds, making of, 57
 height of, 57
 Benders, 7
 Bengal cotton, 30
 Blue stained standards, 168
 Body, 174
 Bollies, 7
 Bolls, description of, 21
 factors influencing number set, 189
 method of opening, 22
 number of days required for development, 22
 number required to make a pound of seed cotton, 21
 Boll weevil cotton, 126
 Bone meal, source of, 85
 Botanical classification, 25
 Bracts, 20
 Bractlets, description of, 20
 number of, 20
 occurrence of, 20
 Branches, arrangement of, 18
 description of, 18
 fruiting of, 18
 origin of, 18
 vegetative, 18
 Breeding, 175
 results of previous work, 175
 ideal, necessity for an, 180
 Bull cotton, 190
 Buying of cotton, 163
 By-products of the cotton plant, 192

C

Canebrake cotton, 7
 Calcium cyanamid, source of, 84
 value as a fertilizer, 95, 96
 Calcium nitrate, value as a fertilizer, 96

- Character of lint, classification according to, 172
- Characters, alleomorphic pair of, 185, 186
- dominant, 185, 186
 - inheritance of, 185
 - linkage of, 180
 - recessive, 185, 186
 - seldom found together, 179
- Characteristics, of early fruiting plants, 178
- of rapid fruiting plants, 178
 - of late fruiting plants, 178
 - of medium fruiting plants, 178
 - of productive plants, 178
 - of storm-resisting plants, 179
- Checking of cotton rows, 63
- Chemistry of cotton plant, 31
- Class, definition of, 170
- Classing of cotton, 165
- Climate of cotton belt, uniformity of, 6
- effect upon cotton lint, 6
 - factors influencing cotton production,
 - humidity, 6
 - frost, 4
 - rainfall, 5
 - sunshine, 3
 - temperature, 3
 - influence upon yield, 6, 234
- Color of lint, factors determining, 168
- Compressing, charges for, 160
- Composition of cotton plant, 34
- Consumption of cotton in the United States, 228
- Coöperative associations, addresses of, 248
- Cost, of ginning, 150
- of production, 148
- Cotton acreage harvested by states, 1879-1924, 224
- Cotton belt, location of, 4
- Cotton famine, 203
- Cotton mills, history in the United States, 202
- Cotton regions of the world, 198
- Cottonseed by-product industry, development of, 192
- hulls, feeding value of, 196
 - meal, composition of, 87, 193
 - tons exported, 1875 to 1924, 232
- Cottonseed meal, feeding value of, 196
- manufacture of, 193
 - quantities to feed to livestock, 197
 - source of, 84
 - tons produced in the United States, 1875-1924, 232
 - toxic properties of, 196
 - use as a fertilizer, 94, 95, 194
 - oil, prejudices against, 192
- Country damage, 155
- Creeks, 7, 8
- Cultivation, level, 59
- number of, 70
 - practices in cotton belt, 75, 76, 77, 78, 79
 - Sea Island cotton, 73
 - time of first, 69
- Cultural practices followed, Ellis County, Texas, 75
- Giles County, Tennessee, 77
 - Jefferson County, Florida, 75
 - Mississippi Delta, 79
 - Robeson County, North Carolina, 77
- Culture of cotton, 55

D

- Days of the growing season, clear and sunny, 3
- Deficient moisture, influence on yield, 234
- Delinting seed, 60
- directions for, 61
 - influence, on germination, 61
 - on yield of seed cotton, 61
 - materials needed, 61
- Determination of soil needs, 89
- Diseases, 103
- angular leaf spot, 110
 - description of, 110
 - means of control of, 111
 - anthracnose, 108
 - description of, 108
 - means of control of, 109
 - cotton varieties usually free from, 109
 - cotton varieties most susceptible to, 110
 - areolate mildew, 114

Diseases, ascochyta canker, 114
 black arm, 110
 black rust, 112
 description of, 112
 means of eradicating, 112
 blue cotton, 113
 diplodia boll rot, description of, 111
 eradication of, 111
 extent of damage from, 103
 influence on yield, 234
 leaf-blight, 114
 of minor importance, 113
 root knot, 106
 sore shin, 113
 Texas root rot, description of, 111
 eradication of, 112
 true rust, 114
 wilt, 113
 Distance between plants in row, 66
 Drag, 174
 Dried blood, source of, 84
 Dusting machinery, description of, 142
 hand guns, 142
 power dusters, 142
 saddle guns, 142
 types of, 141, 142
 Dynamiting land for cotton, 59

E

Earliest authentic mention, 1
 Early against late chopping, 65
 cultivation and chopping, 65
 Egyptian cotton, description of, 29
 fiber, diameter of, 173
 length of, 173
 strength of, 173
 yield of, 29
 Essential elements of plants, 32
 Excessive moisture, influence on yield, 234
 Exports of cotton from the United States,
 161, 228

F

Factors controlling cotton production, 3
 Farmyard manure, agricultural value of,
 183
 commercial value of, 183
 Feeding value of cotton, 195
 Fertilization, factors influencing flower, 35

Fertilizers, 81
 acid phosphate, manufacture of, 86
 source of, 85
 amounts to use, 91, 92, 94, 101
 application of, 101
 basic slag, source of, 85
 composition of, 87
 comparative value of muriate of potash
 and kainit, 96
 effect on earliness, 92
 formulas, interpretation of, 87
 home mixing, 97
 influence of unbalanced, 90
 mixture most commonly used, 101
 nitrogenous, 83
 amount to apply, 93
 comparative value of, 94, 95
 effect on earliness, 91
 inorganic, 85
 organic, 85
 use of, 92
 oldest experiment in South, 101
 phosphatic, 85
 effect on earliness, 91
 use of, 96
 potassic, 86
 effect on earliness, 91
 use of, 96
 return from, 101
 that should not be mixed, 98
 value of, 91, 99, 100
 value of nutrients removed by cotton
 crop, 89
 Fish scrap, source of, 84
 Flowers, color of, 21
 description of, 20
 location of nectaries, 21
 time required for development, 20
 Freight rates for cotton, 160
 Frost, 4
 first killing in fall, 4
 influence of, 4
 last killing in spring, 4
 number of days free from, 4
 Future market, 162

G

Genus *Gossypium*, description of, 25
 Germination of pollen grains, 35

Gin compresses, 153
 Ginneries, number of, 154
 types of, 150
 Ginning practices, 149
 cost preparatory to, 150
 time required for, 151
 Gins, types of, 150
 Gossypol, 197
 Grades, 166
 factors determining, 166
 Grading, of lint, 165
 of seed, 62
 Gray standards, 168
 Gulf cotton, 7

H

Handling of cotton at ginnery, 152
 Harrow, use of spike-tooth, 69
 Harvesting of cotton, 144
 History, early, 1
 in eastern hemisphere, 1
 in western hemisphere, 2
 of cotton manufacture since 1865, 203
 of cotton production, during and immediately after World War, 204
 from 1865 to 1914, 203
 in the United States, 201
 Hoeing, frequency of, 68
 Hulls, tons produced in the United States, 1875 to 1924, 232
 use made of, 193
 Humidity, 6
 influence on Sea Island cotton, 6
 on fungous diseases, 6
 Hybridization, improvement by, 184
 time of, 187

I

Imports of cotton into the United States, 228
 Importance of cotton before the Revolutionary War, 202
 Indian cotton, description of, 28
 fiber, diameter of, 173
 length of, 173
 strength of, 173
 Insects, 115
 army worm, 136
 boll weevil, control of, 127

Insects, boll weevil, description of, 117
 Florida method of controlling, 126, 129
 determination of infestation of, 124
 hibernation of, 119
 influence on yield, 234
 insect enemies of, 120
 introduction of, 116
 life history of, 118
 means of poisoning, 120
 molasses spray for, 121
 period of dispersion of, 118
 period of incubation of, 118
 profitableness of poisoning, 121
 punctures, 118
 recommendations for dusting, 121
 spread of, 123
 boll worm, description of, 132
 means of combatting, 133
 caterpillar, 136
 life history of, 136
 cutworms, control of, 141
 description of, 141
 inch worm, 136
 leaf worm, 136
 combatting the, 137
 description of, 137
 life history of, 136
 major or more important, 115
 Mexican cotton boll weevil, 116
 minor or less important insects, 115
 pink boll worm, 134
 combatting the, 136
 description of, 135
 dissemination of, 134
 introduction of, 134
 plant lice, 124
 red spider, 137
 control of, 139
 description of, 137
 plants attacked by, 137
 root louse, control of, 141
 description of, 141
 Introduction into China, 1
 into Japan, 1
 Invention of the cotton gin, 203
 Involucre, 20

K

Kainit, 86, 87, 96

L

- Leaching losses, 88
- Leaf, 7
- Leaves, color, 20
 - description of, 19
 - photoelectric movement, 20
- Legumes, value of, 98, 100
- Length of growing season, 4
- Light stained standards, 168
- Lime, influence on yield, 81
 - need of, 81
- Lint, classification according to length, 170
 - description of, 22
 - foreign material in, 169
 - index of cotton, 178
 - length and diameter, 23
 - number of twists per inch, 22
 - percentage, 41
 - tensile strength of, 23
- Linters, absence of, 23
 - annual production in bales, 1875 to 1924, 232
 - 1899 to 1923, 222
 - color, 23
 - description of, 23
 - use of, 193
- Lock of cotton, 23
 - influence of number per boll, 179
- Long staple cotton, percentage lint of, 41

M

- Machined cotton, 7
- Male stalks, 190
- Mallow family, 25
- Malvaceae, 25
- Manure (see Farmyard Manure)
 - salts, 86, 87
- Market, definition of, 161
 - kinds of, 162
- Marketing of cotton, 158
- Minor cotton regions of the world, 200
- Morphology of cotton plant, 16
- Motes, 170
- Muriate of potash, 86, 87, 96

N

- Neps, 170
- Nectaries, location of, 21

- Nights, influence of cool, 4
- Nitrogen, influence on growth, 91
 - need of, 82
- Number of plants per acre, 63

O

- Official cotton standards, available types of, 167
 - history of, 166
 - major divisions of, 166
- Oil, gallons, exported 1875 to 1924, 232
 - produced in the United States 1875 to 1924, 232
 - mills, number in the United States, 194
- Origin of cotton, 2
 - of varieties, 45
- Orleans, 7

P

- Peelers, 7, 8
- Peduncle, 20
- Period of most rapid growth, 3
- Perished staple, 173
- Peruvian cotton, 30
- Phosphorus, influence on growth, 91
 - need of, 82
- Photosynthesis in cotton, 34
- Physiology of the cotton plant, 31
- Picking, method of, 145
 - process of, 145
- Pima cotton, origin of, 207
- Plant cells, description of, 31
- Planters, 63
- Planting of seed, 63
- Plants, composition of, 89
 - grown per acre, 68
- Plowing, depth of, 58
 - influence on plant nutrients, 55
 - practices, 55, 56
 - preparing the land for, 56
 - time of, 55
 - under boll weevil conditions, 55
- Potassium, influence on growth, 91
 - need of, 82
 - source of, 86, 87
 - value of, 96
- Potash (see Potassium)

Pollen, amount produced, 21
 description of, 21
 Pollination, method of, 187
 preparation for, 187
 Preparation of seedbed, 59
 Prices received for cotton, factors influencing, 159
 Production, by states, 1839 to 1923, 220
 by specified countries, 215
 in Brazil, 199
 in China and Chosen, 198
 in Egypt, 197
 in India, 198
 in Russia, 199
 in the United States, 198, 228
 influence of storing on, 203
 of American-Egyptian cotton 1900 to 1924, 222
 of Sea Island cotton, 1900 to 1924, 222
 of world for 1900 to 1924, 219
 Pruning, 71
 Pulling of staple, method of, 171
 Purchase of seed, 60

Q

Quantity of seed to plant, 63

R

Rainfall, 5
 average, for cotton belt, 5
 for eastern North Carolina, 5
 for Oklahoma and Texas, 5
 for picking season, 5
 for southern Mississippi, 5
 driest season, 5
 influence of, 5
 excessive, 5
 summer, 5
 spring, 5
 wettest month, 5
 Rate of absorption of plant nutrients, 33
 Ratooning, 209
 Red River, 7
 Resin glands, 19
 Rivers, 7, 8
 Roller gins, 150
 Rolling of seed, 63

Roots, description of, 116
 origin of secondary, 16
 Root knot, crops susceptible and immune to, 107
 description of, 107
 means of eradicating, 107
 varieties of cotton resistant to, 108
 Rotations for cotton, 73
 objection to common, 74
 value of, 99
 Route from farm to spinner, 158
 Rows, distance apart, 69
 Running out of cotton, 176

S

Saw gin, 150
 Sea Island cotton, description of, 28
 fiber of, diameter, 173
 length of, 173
 strength of, 173
 production of, 1900 to 1924, 222
 Season, ideal for cotton production, 6
 Seed, amount of by-products produced per ton, 193
 characteristics of planting, 60
 comparison of graded and unseparated, 64
 cotton, 23
 selling of, 159
 delinting of, 60
 description of, 23
 feeding value of, 196
 information on shipping tag of planting, 60
 influence of rolling, 63
 number per bushel, 63
 quantity to plant, 63
 roll, weight of, 176
 tons produced in the United States, 1875 to 1924, 232
 weight per bushel, of Sea Island, 193
 of Upland, 193
 Selection, continuation of, 183
 improvement by, 178
 of seed, 176
 objects of, 178
 Selections, harvesting plant-to-row, 182
 making of, 180
 testing out of, 181
 Selfing, 184

- Selling of cotton, time of, 163
 of seed cotton, 159
 Shale, 7
 Shedding, influence of early and late
 flowering on, 44
 normal per cent of, 42
 Shipping of cotton, 160
 Short staple cotton, percentage of lint, 41
 Side application of fertilizers, 70
 Single stalk cotton culture, 69
 Sleep movement, 20
 Snapped cotton, 7
 Sodium nitrate, source of, 83
 side applications of, 92, 93, 94, 95, 96
 Soils, characteristics of cotton belt, 10
 for Sea Island, 10
 ideal, for cotton, 9
 location of regions, 13
 regions, average production, 10
 average yield per acre, 10
 of the cotton belt, 9, 10
 relationship to cotton diseases, 10
 topography, 10
 use of fertilizers on, 10
 Source of the essential elements, 33
 Spacing, influence on earliness, 68
 influence on size of boll, 68
 influence on yield, 68
 Species, classification of, 25
 number of, 25
 Spindles, number in, leading counties, 235
 various countries, 234
 Spot market, 162
 Spotted standards, 168
 Square, 20
 Stalks, destruction of, 56
 Standard warehouses, 156
 Stem, color of, 18
 description of, 17
 Stoma, number of, on cotton leaf, 34
 Strength of fibers, 173
 Stringy cotton, 170
 Sub-soiling, 58
- T
- Tankage, source of, 84
 Temperature, 3
 average summer, in American-Egyptian district, 4
- Temperature, average summer, in cotton
 belt, 4
 mean daily, during normal years, 4
 Texas cotton, 6
 characteristics, 7
 Thurberia, 209
 Time of planting, 63, 64
 Time of picking, 144
 Top-dressing, 93, 94
 Topping, 72
 Transportation of cotton, 158
 Translocation of food in the plant, 34
 Transpiration ratio of cotton, 33
 Type of plant most often sought, 178
- U
- Universal standards, 166
 colors recognized by, 168
 grades of, 168
 Uniformity of fibers, 173
 Upland cotton, 8
 characteristics, 8
 fiber, diameter of, 173
 length of, 173
 strength of, 173
 varieties grown in the American-Egyptian cotton belt, 213
 where grown, 8
- V
- Value of cultivation, 70
 Variety test, 46
 Varieties, big-boll group, 38
 characteristics, 49, 50, 236
 classification of, 40
 cluster group, 38
 commonly grown, 53
 desired, 46
 early or King group, 38
 groups of, 36
 grown in American-Egyptian cotton belt, 213
 high ranking, in each state, 48
 intermediate group, 40
 leading, east and west of Mississippi River, 45
 long-limbed group, 39
 long staple Upland group, 40

Varieties, origin, 45
percentage lint, 41
resistant to wilt, 105
Rio Grande or Peterkin group, 38
semi-cluster group, 38

W

Warehouses, capacity of, 156
corporations, service rendered by, 157
distribution of, 156
size of, 156
standard, 156
value of cotton stored in, 155
Warehousing of cotton, 155
Water, amount in cotton plant, 33
irrigation, method of applying, 208
Weeder, use of, 68

Weeds, noxious in cotton field, 75, 77, 78,
79
White standards, 168
Width of rows, 59
influenced by fertility, 60
Wilt, description of, 105
means of eradicating, 106
World's consumption of cotton, 227
Work of the plant breeder, 175

Y

Yellow stained standards, 168
Yellow tinged standards, 168
Yield of cotton, 147, 148
per acre, by states, 1910 to 1924, 226
in specified countries, 223
Yuma cotton, origin of, 207

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